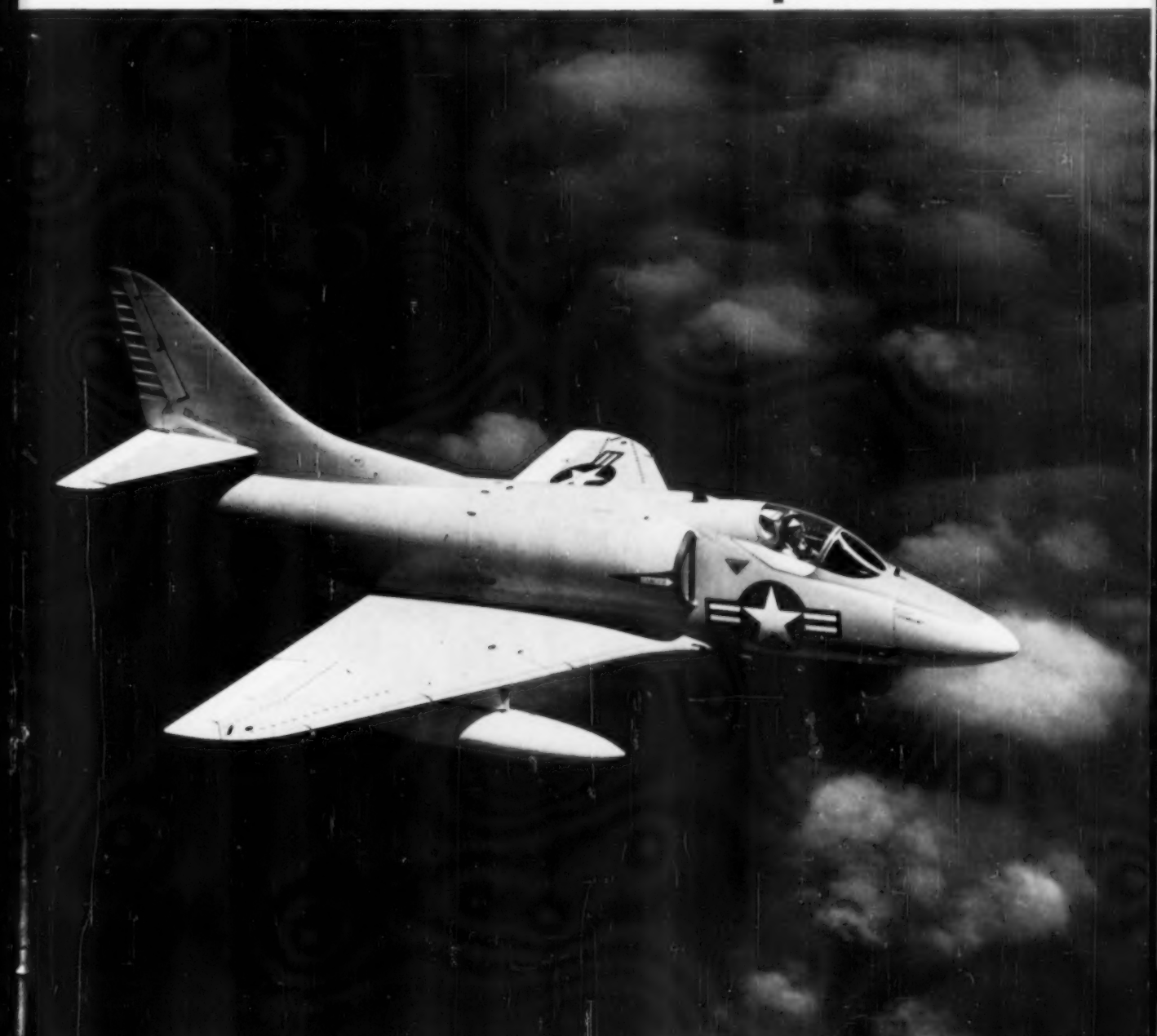
AVIATION WEEK

A McGRAW-HILL PUBLICATION

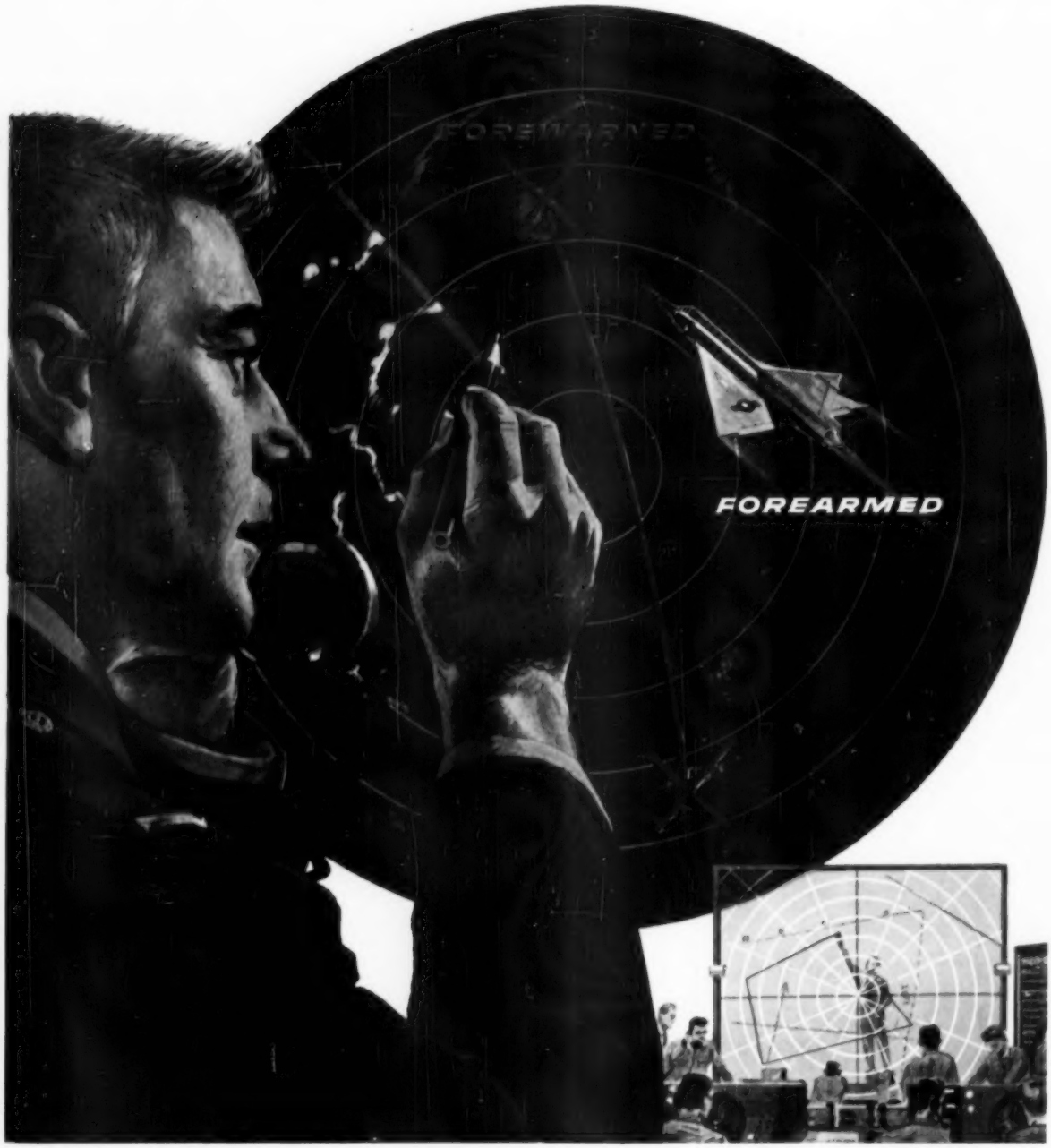
August 26, 1957 50 cents

SEPR Specializes In Rocket Engines For Aircraft Use

Douglas A4D Skyhawk



Simplicity, Economy Guide A4D Design



FOREARMED

The officers and men of the U.S.A.F. Aircraft Control and Warning searching the heavens 'round the clock with radar, are the guiding hands behind America's air defense. Through their diligence, our Interceptors are *forewarned* and electronically directed to any unidentified aircraft.

The pilots of the U.S.A.F. Air Defense Command are *forearmed* with advanced weapons systems like Convair's supersonic F-102A all-weather delta Interceptor. From the ground up, this formidable air defense team is keeping an eye on your freedom!

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- EXPLOSIVE ORDNANCE TESTING
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Rheem Ordnance Engineering is prepared to conduct complete programs in the field of ordnance systems including:

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AVIATION CALENDAR

Aug. 31-Sept. 1—Midget Airplane Races, Ft. Wayne, Ind.

Sept. 1-15—Sixth International Aeronautical Conference, Royal Aeronautical Society and Institute of the Aeronautical Sciences, Folkstone and London, England.

Sept. 2-8—1957 Flying Display, Society of British Aircraft Constructors, Farnborough, England.

Sept. 3-14—11th General Assembly, International Union of Geodesy and Geophysics, in conjunction with International Geophysical Year, University of Toronto, Canada.

Sept. 7—Second Annual Convention of the OX-5 Club, Hotel Phillips, Kansas City, Mo.

Sept. 8-13—Second Annual Course on Investment Castings, Massachusetts Institute of Technology, Cambridge, Mass.

Sept. 9-11—15th Annual Meeting, Electron Microscope Society of America, Massachusetts Institute of Technology, Cambridge, Mass.

Sept. 9-13—Twelfth Annual Instrument-Automation Conference and Exhibit, Cleveland Auditorium, Cleveland, Ohio.

Sept. 13—Third Pacific Area National Meeting, American Society for Testing Materials, Sheraton-Palace Hotel, San Francisco, Calif.

Sept. 14-15—Meeting of Antique Airplane Assn., Ottumwa, Ia.

Sept. 15—1957 Garden Party and Flying Display, Royal Aeronautical Society, Wisley Aerodrome, Weybridge, England.

Sept. 23-25—Fall Meeting American Society of Mechanical Engineers, Statler Hotel, Hartford, Conn.

Sept. 25—Pratt & Whitney Aircraft Engine Maintenance and Operation Forum, sponsored by Southwest Airmotive Co., Melrose Hotel, Dallas, Tex.

Sept. 26-27—Fifth Michigan Aeronautics Conference, jointly sponsored by University of Michigan Transportation Institute, Western Michigan University, and The Aero Club of Michigan, Alpena, Mich.

(Continued on page 6)

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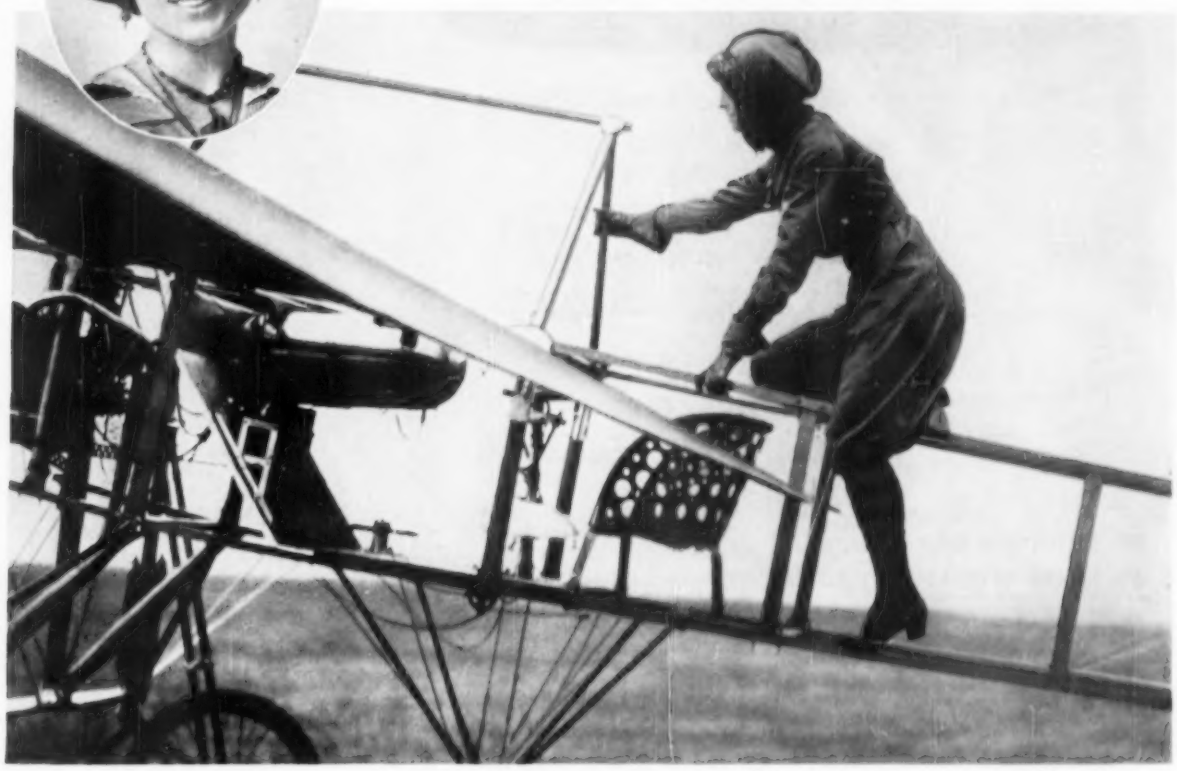
Flying Fair Lady

—Harriet Quimby, America's First Licensed Woman Pilot



(Photos courtesy Institute of Aeronautical Sciences)

Pretty Harriet Quimby attained success in two masculine strongholds—journalism and aviation—in a day when women were not even allowed to vote.

While still in her teens, Miss Quimby became a newspaper reporter in San Francisco; and, in a short time, advanced to the position of Drama Editor on Leslie's Weekly in New York. There she learned to fly under the guidance of John Moissant, famous early-day aviator. It was on August 1, 1911, that Miss Quimby became America's first licensed woman pilot. Then, following months of preparation, Miss Quimby flew the English Channel on April 16, 1912—the first woman to do so.

Miss Quimby returned to America and made exhibition appearances in this country and Mexico. Noted for her beauty as well as her daring, Miss Quimby was a symbol of increasing feminine equality for American women.

● A pioneer in research and development of aviation fuels, Phillips Petroleum Company is, today, a foremost supplier of high octane gasoline for commercial, private and military aircraft. In step with the future, Phillips is a leading producer of *super-performance* jet fuels for the latest designs in turbo-props and jets. And Phillips research continues to lead the way for development of fuels for the aircraft of tomorrow.

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The Illustrated OPEN TEMPERATURE PICK-UPS are precision platinum resistance thermometers capable of high-speed temperature measurement of gases and non-corrosive fluids. Resistance winding, supported on ceramic-insulated posts or on card, is in direct contact with environment to be measured, and can have time constants as fast as 50 milliseconds. Full-scale output voltages of 5-volts can be delivered directly to telemetry commutation circuits. Units operate over selected ranges from −320F to +750F (−200C to +400C), with accuracy better than ±1% of full scale and repeatibility of ±0.2%. Calibration Certificate giving precise 5-point calibration supplied with each unit. Stainless steel case and rugged construction withstand 1500 psia pressures, ±25 g vibration, and 60 g shocks under MIL-E-5272A. Send for Technical Bulletins 1182 and 1350.

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AVIATION CALENDAR

(*Continued from page 4*)

Sept. 28-29—North Central Regional Conference, Civil Air Patrol, Town House Hotel, Kansas City, Kans.

Sept. 30-Oct. 5—National Aeronautic Meeting, Aircraft Production Forum & Aircraft Engineering Display, Society of Automotive Engineers, Hotel Ambassador, Los Angeles.

Oct. 2-4—Tenth Annual Meeting and Forum, National Business Aircraft Assn., Cosmopolitan Hotel, Denver, Colo.

Oct. 5—First Annual Awards Banquet, Society of Experimental Test Pilots, Beverly-Hilton Hotel, Los Angeles.

Oct. 7-9—13th Annual National Electronics Conference, Chicago, Ill.

Oct. 7-10—Triennial Inspection, Lewis Flight Propulsion Laboratory, Cleveland.

Oct. 7-12—Eighth Annual Congress, International Astronautical Federation, Barcelona, Spain. For details write: IAF, 35 Lowell Rd., Concord, Mass.

Oct. 8—Tenth Annual Airport Development and Operations Conference, Onondaga Hotel, Syracuse, N. Y.

Oct. 9-11—Annual Meeting, Society for Experimental Stress Analysis, El Cortes Hotel, San Diego, Calif.

Oct. 10-11—National Noise Abatement Symposium, Sherman Hotel, Chicago, Ill.

Oct. 16-18—Conference on Computers in Control, American Institute of Electrical Engineers, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

Oct. 16-18—1957 IRE Canadian Convention, Automotive Building, Exhibition Park, Toronto, Ont., Canada.

Oct. 17-18—13th Annual Convention, The Magnesium Association, Biltmore Hotel, New York.

Oct. 21-22—Canadian Aeronautical Institute-Institute of the Aeronautical Sciences Meeting, Montreal, Canada.

Oct. 21-23—Conference on new developments in the field of power, American Society of Mechanical Engineers, Americus Hotel, Allentown, Pa.

Oct. 21-25—45th National Safety Congress, Conrad Hilton Hotel, Chicago.

Oct. 24-25—Fourteenth Annual Display, Aircraft Electrical Equipment, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 28-31—Second Winter Meeting, American Nuclear Society, Henry Hudson Hotel, New York.

Oct. 28-29—Third Annual Meeting, Association of the U. S. Army, Sheraton-Park Hotel, Washington, D. C.

Oct. 28-30—Annual East Coast Conference on Aeronautical and Navigational Electronics, Fifth Regiment Armory, Baltimore, Md.

Oct. 28-31—National Industrial Packaging & Handling Exposition, Atlantic City, Convention Hall, N. J.

Oct. 30—Aviation Electrical Equipment Display, U. S. Grant Hotel, San Diego.

Nov. 5-7—Joint Military-Industry Guided Missile Reliability Symposium (limited to those with Secret security clearance), Naval Air Missile Test Center, Pt. Mugu.

Nov. 6-8—Third Annual Symposium on Aeronautical Communications, Hotel Utica, Utica, N. Y.

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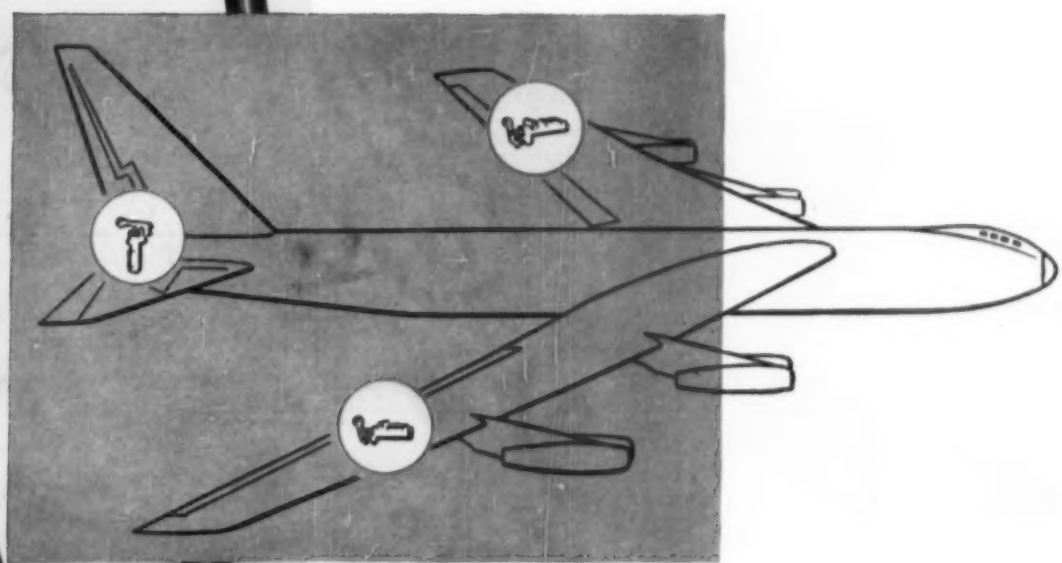

Flight control of jet-age global aircraft takes more than human horsepower—it requires servo-systems which must perform under critical conditions over long periods of continuous operation. LINEAR has developed "O" rings and seals that keep the serve in servo-systems—to keep these planes in the air longer—safely.

For these critical requirements, LINEAR developed precision "O" rings molded of the newest elastomers to meet the most rigid specifications. They will withstand temperatures of from −130° to 550°F —give long service life under severe mechanical abuse—and will withstand the destructive action of such fluids as silicate and phosphate esters, hydrocarbons and synthetic lubricants.

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Bridgeport is proud of playing a part in helping to bring this bomber of tomorrow into being by supplying high-strength aluminum extrusions and forgings used in the Hustler.

This new Convair bomber is another of the many military and commercial aircraft in which Bridgeport aluminum is used. It gives added recognition to the dependable service Bridgeport supplies in furnishing high-quality aluminum extrusions and forgings to meet aircraft requirements.

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The Air Force Ryan X-13 Vertijet—able to take off and land on its jet thrust in an area half the size of a tennis court—brings a new dimension to air power. This revolutionary concept combines missile mobility, helicopter maneuverability, and jet speed. Not dependent on vulnerable runways or carrier decks, jet VTOLs make possible wide dispersal of aircraft in land theatres or on small ships in naval task forces—and can reach fighting altitude before most other jet planes can complete take-off.

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The unique performance of the X-13 is achieved by its advanced jet reaction control system. A product of Ryan engineering, it provides complete control of the airplane during hovering, zero-speed flight and in transition. Operated by conventional pilot's controls, the system requires no higher level of skill than that needed to fly a helicopter.

The X-13 opens a new chapter in aviation history. It began at Ryan ten years ago—the first jet VTOL program in the world. Since then, working in the closest cooperation with the Air Force and the Navy, Ryan has successfully carried out one of the most intensive and inventive engineering research projects of our time.

This imaginative and energetic effort is typical of Ryan's work—in every field of aeronautics.

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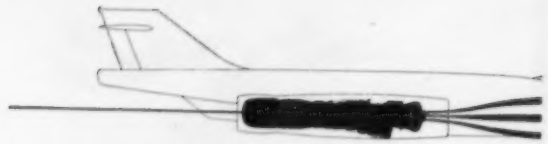

The building of quality jet engines is just half the job—the other half is building them on time.

On the face of it, you'd think turning out engines *on schedule* an easy task for volume production people like us. We make thousands of detail parts in our own plant; add to these thousands more received from suppliers all over the United States and you can see that timing is the key to schedule performance.

Keeping on schedule is important because the Air Force and aircraft manufacturers base their commitments on our production performance. If we miss—they miss.

On-time volume delivery is something that comes only from volume production experience. In this business of jet engine-making, there's no short-cut to being able to meet schedules . . . you've got to know your business.

And our business is producing highest quality jet engines, *on schedule*, at lowest possible cost.

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Resistance Welding of Jet Engines

SCIAKY

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Pratt & Whitney Uses Sciaky Techniques To Slash Weight of J-57 Engines

The replacement of silver brazed steel with Sciaky resistance welded aluminum has made possible a significant weight reduction in Pratt & Whitney Aircraft's J-57 jet engine.

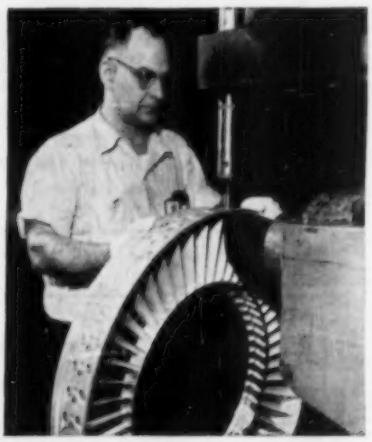
The part affected is the shroud stator of the compressor section. Before the huge Sciaky welders were put into service, the shroud stators were made of steel, fabricated with a silver brazing process.

As a result of Pratt & Whitney's constant research for improvement, project engineers recommended the use of aluminum. Experiments showed that resistance welding, under the 7500-pound pressure delivered by the Sciaky machines, was the only means by which the aluminum pieces could be joined without weldment cracks.

Five Sciaky patented Three-Phase welders producing a total of 740,000 secondary amperes used for this operation represent the largest concentration of such machines in the world. They are described by Pratt & Whitney Aircraft as the only welders capable of satisfactorily welding the aluminum shrouds.

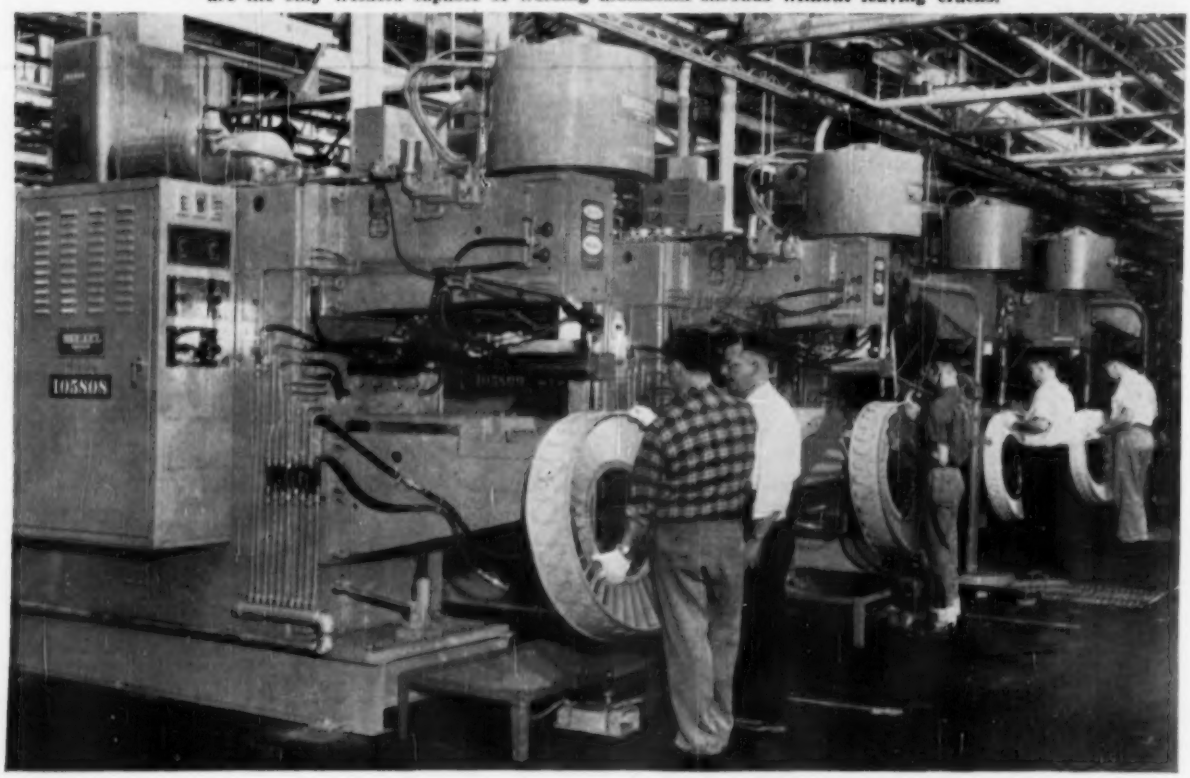
Three of the five welders are equipped with Sciaky Predetermined Electronic Counter Controls. The unique control makes it possible for users to get precisely what they set on the machine. There is no deviation and settings are consistent through the entire range of adjustment. Setup to repeat previous runs is simple.

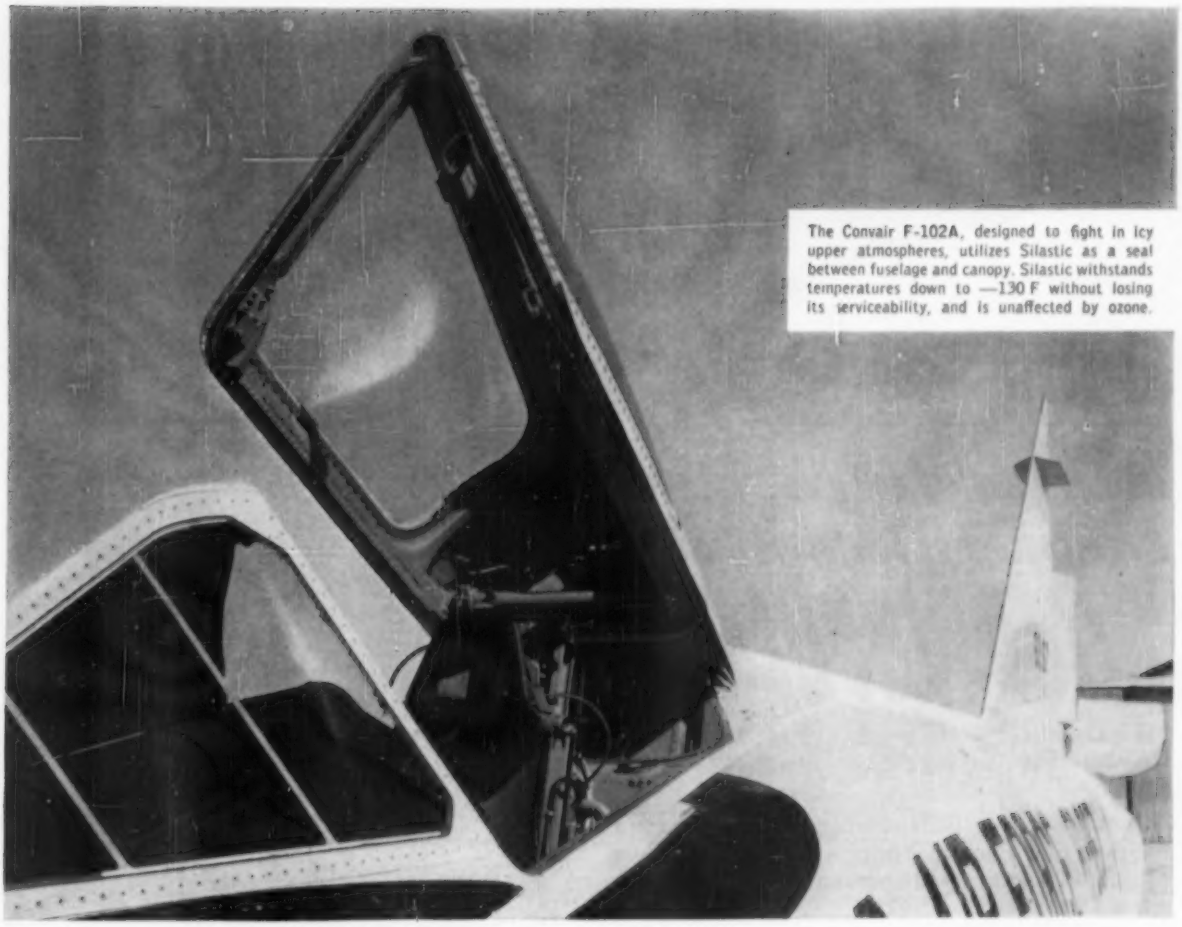
For further information, write today for Bulletins No. 338 and 339. Sciaky Bros., Inc., 4935 W. 67th St., Chicago 38, Ill., POrtsmouth 7-6500.



Close-up of the shroud stator being resistance welded.

Four Sciaky patented Three-Phase welders installed in the East Hartford plant of Pratt & Whitney Aircraft. Since the photo was taken, a fifth machine has been added. They are the only welders capable of welding aluminum shrouds without leaving cracks.





The Convair F-102A, designed to fight in icy upper atmospheres, utilizes Silastic as a seal between fuselage and canopy. Silastic withstands temperatures down to —130 F without losing its serviceability, and is unaffected by ozone.

SILASTIC seals stay airtight at -130 F

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In sub-zero cold that would ruin the usefulness of organic rubber, seals of Silastic*, the Dow Corning silicone rubber, stay resilient and effective. Silastic is resistant to ozone, weathering, and temperature cycling from —130 to 500 F. It has very low compression set. Silastic parts are offered in a variety of shapes, sizes, and colors by leading rubber fabricators.

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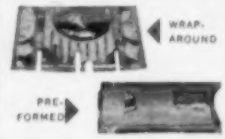

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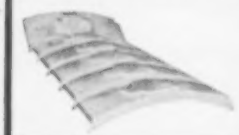

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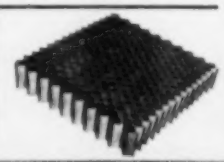
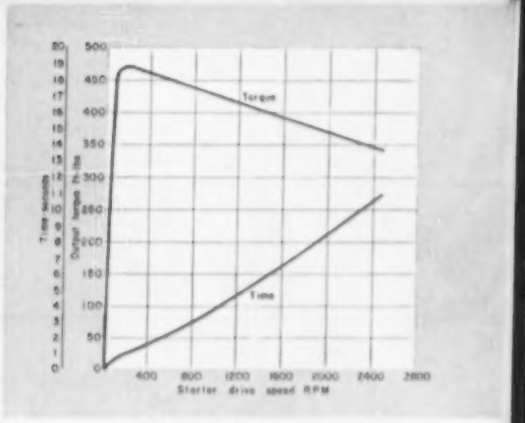
For Military, Industrial and Commercial Products. REFRASIL Cloth, combined with High Temp Resins, is possible liner for Missile uses. Typical High Temp Aircraft parts shown.

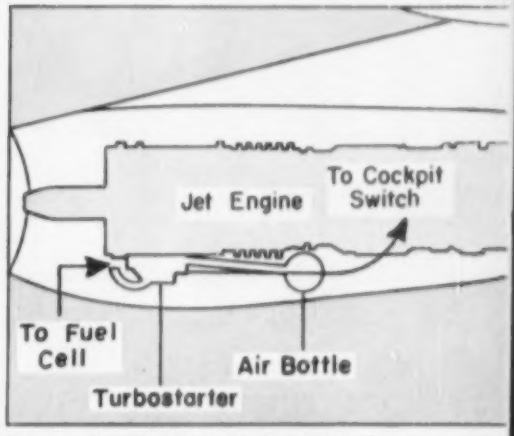
HITCORE Honeycomb
In Stainless Steel and a variety of other materials. Various thicknesses, core sizes and foil gages can be combined to meet your special requirements.



Production model of the General Electric fuel-air turbostarter for a current high thrust engine weighs only 46 pounds, has an 8¾-inch diameter and 12⅜-inch length. Rated torque is 485 foot-pounds and a cut-out speed of 2500 rpm is reached in 10.8 seconds.



Fast starting capability of a turbostarter for a 525 lb-ft² moment of inertia jet engine is shown by this performance curve.



No ground equipment is needed. The self-contained G-E turbostarter operates on the aircraft's air and fuel supply alone.

46 Pound General Electric Turbostarter Will Give Jet Airliners

25 Second Start Without Using Ground Carts

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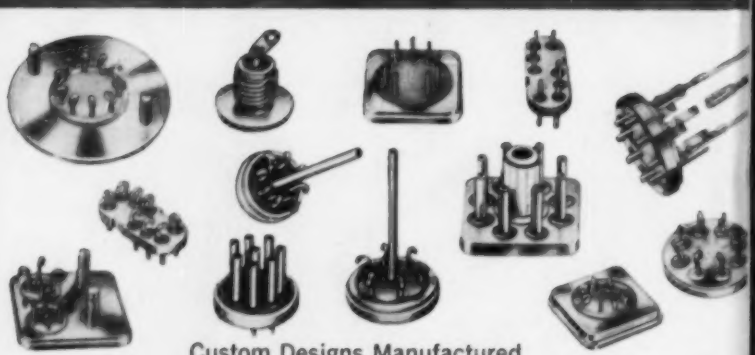

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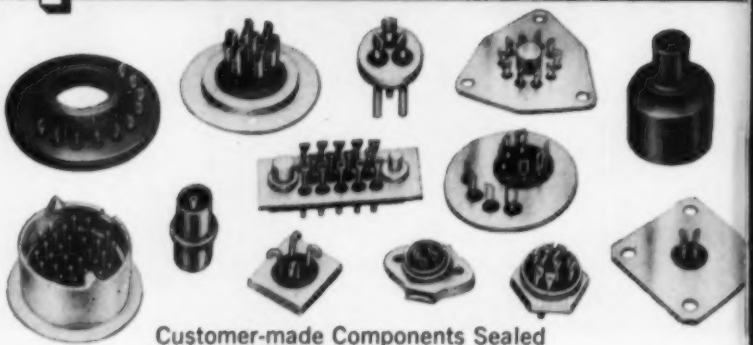

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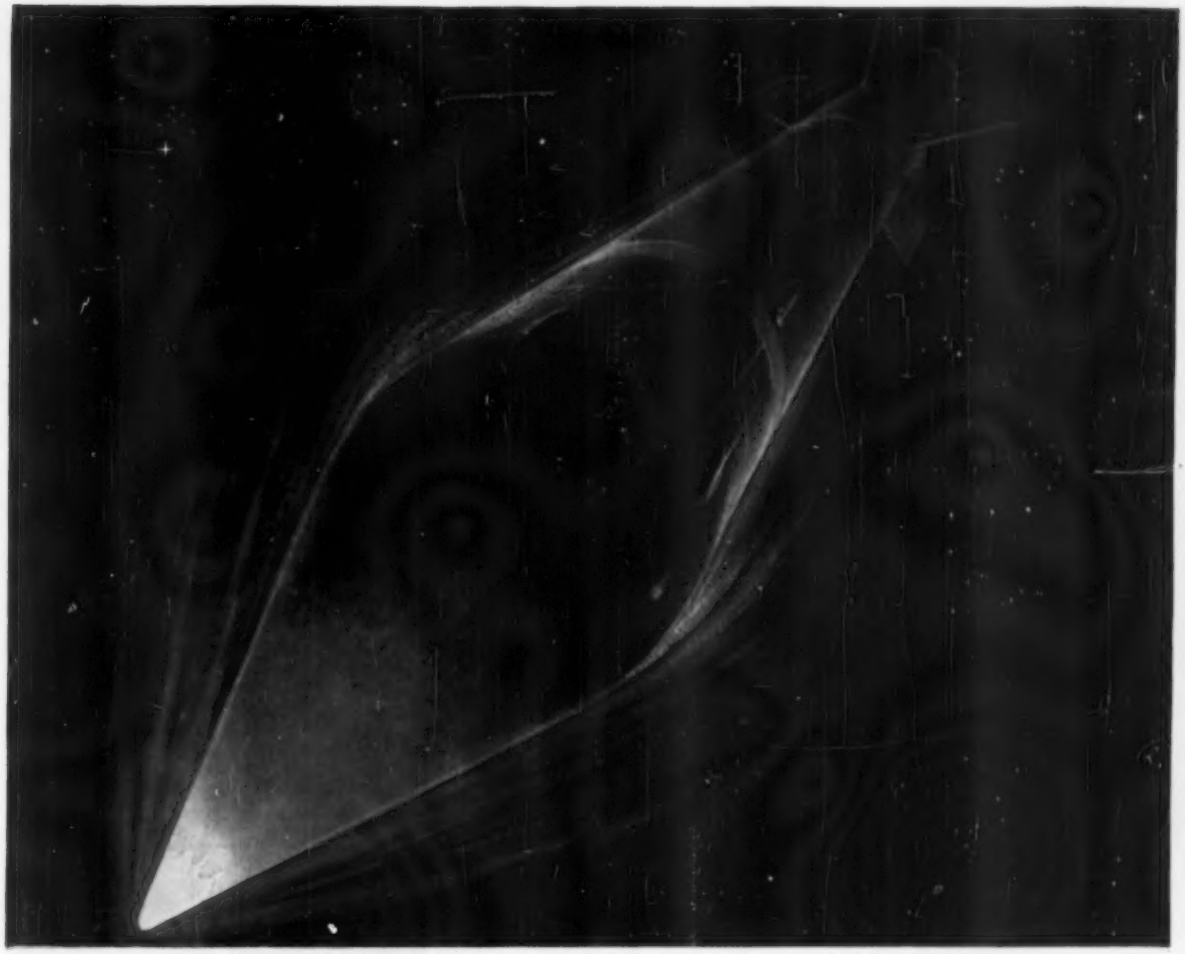

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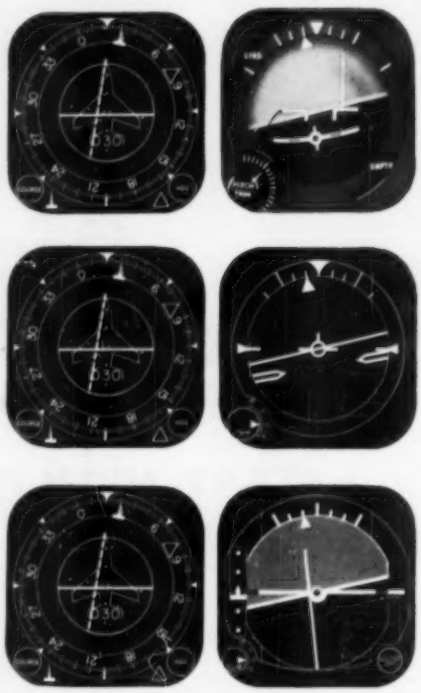
COURSE DEVIATION INDICATOR | FLIGHT DIRECTOR INDICATOR



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August 26, 1957

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COVER: Douglas A4D-2 in production for Navy represents a design effort to reverse the trend toward complexity in aircraft. Compared to earlier AD types, A4D has about one-third as many structural detail parts. Underwing pylons can carry fuel or armament, and nuclear weapon can be carried on belly mount. A4D also can be fitted as buddy tanker. Complete A4D design story is on page 50.

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AVIATION WEEK • August 26, 1957 • Vol. 67, No. 8

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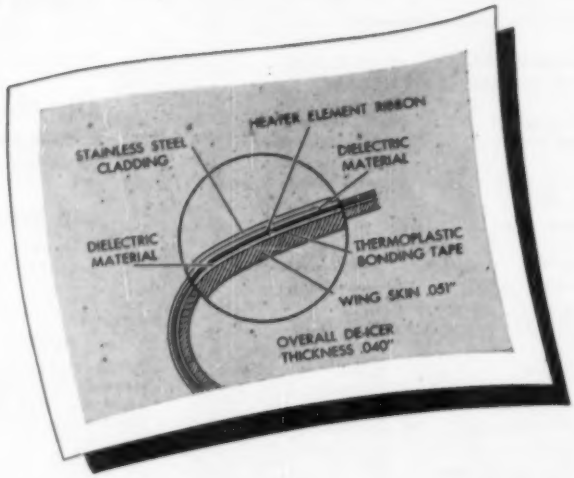
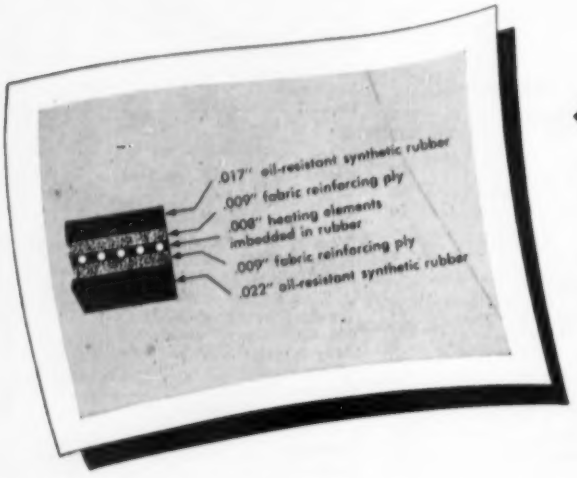
B. F. Goodrich answers de-icing problems 3 ways

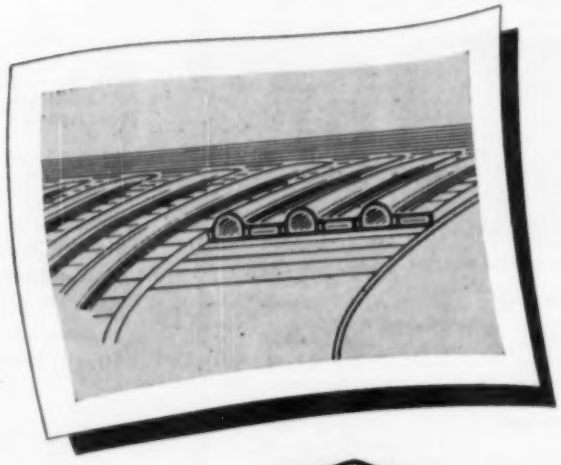
1. METAL-CLAD DE-ICERS — Lightweight B.F.Goodrich metal-clad De-Icers, as used on Boeing's KC-135 stabilizers, are highly resistant to abrasion and erosion from rain and hail. Ribbon-type electrical heating elements are sandwiched between layers of resin-impregnated glass fabric, topped by an exterior skin of stainless steel or other specified metal. Pre-shaped to the contour of the airfoil's leading edge, this De-Icer is attached with an adhesive bond.




.017" oil-resistant synthetic rubber
.009" fabric reinforcing ply
.008" heating elements imbedded in rubber
.009" fabric reinforcing ply
.022" oil-resistant synthetic rubber

2. HEATED RUBBER — B.F.Goodrich electrically heated rubber is a lightweight method of supplying heat for ice control in localized areas such as air intakes, cowls, propeller blades and spinners. Typical applications—Lockheed's Constellations and C-130. Heating elements arranged for proper heat pattern are sandwiched between thin, flexible sheets of rubber to fit complex curves or flat surfaces. Power density can be as high as 40 watts psi — overall thickness as small as .030".

3. PNEUMATIC DE-ICERS — B.F.Goodrich Pneumatic De-Icers offer the best method of ice removal for large areas. Small, rubber-reinforced fabric tubes, built in line with the air stream, inflate and deflate to snap off ice. This chordwise tube arrangement used on planes such as Lockheed's Super-Constellation series and the Grumman Albatross, smooths the flow of air over airfoil surfaces during the brief inflation period. This type of De-Icer is also being used on radomes because its pneumatic operation offers minimum interference with the radar signal.



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EDITORIAL

Are We Really Saving Money?

Air Force and Navy have now completed most of their procurement reprogramming for Fiscal 1958 in order to stay under the expenditure ceilings imposed by the executive branch of the government. Some further pruning remains to be done, notably in research and development programs and in the missile area where duplications and technically retarded projects still abound. It is now possible to take a good look at just how much genuine economy this reprogramming will provide and what effects it will have on the strength of military airpower.

The principle tactic of the military services to stay under the Fiscal 1958 expenditure ceiling has been the production stretchout. Virtually every major aircraft production program for both services has been stretched to provide a lower rate of production and to defer deliveries of finished products to later dates. The fiscal attractiveness of this policy does not lie in saving money but rather in the fact that it pushes the payment of the bills for completed aircraft forward into another fiscal year.

What Stretchout Means

The stretchout doesn't save any money because the bills for the completed hardware must eventually be paid. As a means of solving fiscal problems the production stretchout resembles the housekeeper who cleans her floors by sweeping all the dirt under the rugs.

The production stretchout also means a significant delay in the modernization of combat equipment. It means that Strategic Air Command will be re-equipped with B-52 bombers and KC-135 jet tankers years later than originally scheduled. It means that Air Defense Command will not get its new generation of Mach 2 interceptors until much later than originally scheduled. It means that the Forrestal class of Navy aircraft carriers will have to continue to operate longer with a complement of obsolescent fighters and bombers.

Another policy promoted with an air of economy is the 5% reduction in progress payments to military contractors. This again simply defers bills and will not save a single penny. The reduction in progress payments plus the production stretchout may defer the final airpower hardware bill considerably, but it does not alter the fact that sooner or later it will have to be paid.

'One-Shot Economies'

The recent history of the military airpower program has been dominated by the philosophy of deferred payment for the airpower bill. At the end of the Korean war, a re-evaluation and slow down of the war emergency production rates was necessary. But since that stretchout there has been a continued stretching of the airpower program with each new budget until now it is stretched pretty close to the breaking point, and vital portions of a truly balanced and effective airpower program, such as modern transports, are being dropped completely.

For several years, the Defense Department has been telling Congress that "we can make these one-shot economies safely this year but next year we will ask for increases that we really need to provide adequate airpower." What has happened is that the "one-shot" economies are made each year, but the promised increase, even when forthcoming, are vitiated by the techniques of deferment such as the production stretchout and reprogramming.

This process has now reached the point where even the Defense Department admits it cannot finance the promised program for an Air Force of 137 combat wings. For Fiscal 1958, the program is cut to 128 wings with USAF Secretary James Douglas already warning that under the expenditure limitations a further cut of nine combat wings is in prospect. But even these combat wings will have their modernization seriously delayed by the production stretchouts. The combination of cutback and stretchout means that we will have a smaller Air Force than planned, equipped with a higher percentage of obsolescent equipment than is technically necessary.

Even more serious are the budgetary vacillations in the research and development field. Research and development funds are high risk capital invested in achieving major technical breakthroughs and adding fundamental knowledge to the state of the art. Timid budgeting in this area can and has resulted in waste of funds without achieving the sought for results.

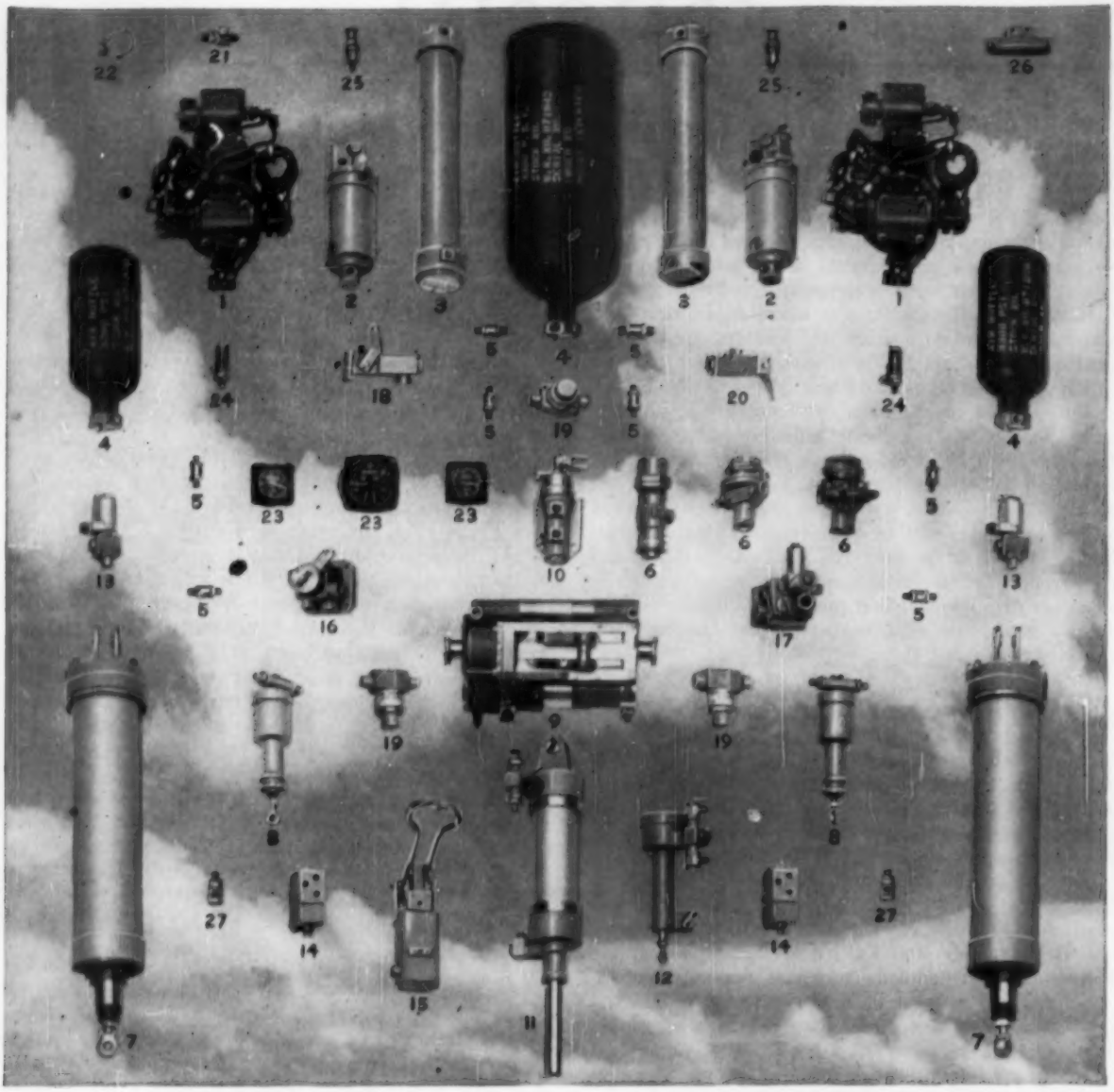
Lesson From History

The development of superior airpower has become such a vastly expensive and technically complex adventure that it is no longer possible to achieve any genuine results without holding steadily to a program course over sufficiently long a period to allow new weapons to incubate from research and development into production and operational use. The history of the postwar decade has indicated that the people of this country appear to understand this fact better than their political leaders.

In the pre-Korean era when President Truman discarded the 70 group Air Force program and held USAF to 48 combat groups, the Republican-controlled Congress backed by popular support fought bitterly for an adequate airpower program. Now in the post-Korea era we face the same situation with the Congress willing to support an adequate airpower program in the face of a grave Communist threat and the executive branch of the government apparently convinced that we can survive with less airpower.

We should learn something from history.

—Robert Hotz



Here it is — all the hardware needed for an all-pneumatic aircraft. All the items shown are pneumatic system components on the new Fairchild F-27, and open the door to an exciting new era of aviation. Similar pneumatic equipment is now available from Kidde on an off-the-shelf basis, and modifications to your own specifications or design requirements are available through Kidde's vast creative engineering department. Let Kidde engineers show you how faster-operating, lighter-weight pneumatic systems can better solve your power problems!

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3. Chemical dryer
4. Air bottle
5. Check valve
6. Pressure reducer
*7. Actuator, main gear
*8. Actuator, up lock main gear
9. Actuator, nose wheel steering
10. Valve, servo, nose steering
11. Actuator, nose gear
12. Actuator, up lock nose gear
13. Valve, propeller brake
14. Valve, wheel brake
15. Valve, emergency brake
16. Valve, emergency landing gear
17. Valve, solenoid, landing gear
18. Valve, manual, isolation
19. Filter
20. Valve isolation
21. Pressure relief
22. Valve, ground charging
23. Pressure gauges
24. Valve, relief
25. Valve, back pressure
26. Shuttle valve
27. Valve, rapid exhaust

Items 7 & 8 designed in cooperation with and furnished by Stratos Division of Fairchild.

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John J. Convey, manager-Washington, D. C. office, Rheem Aircraft Division, Rheem Manufacturing Co., Downey, Calif.

Dr. Arne Wikstrom, special technical assistant to the president, Research and Advanced Development Division, Avco Manufacturing Corp., Lawrence, Mass.

Robert N. Buck, special adviser (jet integration program) to the president, Trans World Airlines, Inc.

Whitney Collins, executive assistant to the president, Solar Aircraft Co., San Diego, Calif.

Edward Rubin, assistant to the president, Wyle Laboratories, El Segundo, Calif.

Honors and Elections

Henri Desbrueres, president and director general of Societe Nationale d'Etude et de Construction de Moteurs (SNECMA), has been elected president of the Union Syndicale des Industries Aeronautiques, Paris, France. **Georges Glasser**, retiring president, and **Marcel Dassault**, vice president, have been appointed honorary presidents.

The Martin Company, of Baltimore, Md., has been named recipient of the John Price Wetherill Medal of The Franklin Institute of the State of Pennsylvania "in recognition of its intensive research, development and manufacture of bonded structures."

Dr. Dean Allen Watkins of Stanford University has been named recipient of the 1957 Electronic Achievement Award of the Seventh Region, Institute of Radio Engineers for "his basic contributions in reducing noise in microwave electron tubes."

Changes

Clifford A. Faust, director-technical services, Consolidated Electrodynamics Corp., Pasadena, Calif. Also: **Robert D. Ridgway**, manager-sales operations.

B. W. Sauter, general manager, Electronic Tube Division, Westinghouse Electric Corp., Elmira, N. Y.

John P. Day, chief development engineer, Kin Tel Division, Cohu Electronics, Inc., San Diego, Calif.

R. G. Murley, export manager, Canadian Steel Improvement Limited, Toronto, Canada.

Kenneth M. Miller, manager-engineering, LearCal Division, Lear, Inc., Santa Monica, Calif.

(Continued on p. 124)

INDUSTRY OBSERVER

► **Total USAF investment in North American Aviation Inc.'s Navaho intercontinental cruise missiles (AW July 15, p. 29) will be approximately $690 million by the time contract termination is completed. Remainder of complete Navaho systems, including booster rocket and ramjet cruise vehicle, probably totals less than half a dozen but these will be fired (AW Aug. 5, p. 26).**

► De Havilland Propellers Ltd. has a contract for a British intermediate range ballistic missile. Test bed, apparently with tankage for liquid oxygen, is visible at de Havilland's Hatfield plant.

► **Aerojet and Allison are combining forces to develop and produce a powerplant for a Mach 3 class commercial transport.**

► Boeing and Douglas are studying possibility of using Curtiss-Wright TJ38 turbojet engines in short-range versions of their DC-8 and 717 transports (AW July 22, p. 48). Advantage is that efficient cycle of TJ38 may permit use of the small jets, which were originally intended for domestic use only, on low traffic density overseas routes.

► **Photographic data showing the exact sequence of Lockheed X-7 ramjet-powered test vehicle tests have been obtained by using combination of airborne and ground cameras. Each wing pod of X-7 mounts three cameras. Lockheed Missile Systems Division also has developed coordination procedure whereby as many as five cameras can be slaved to master unit containing the timing equipment.**

► Republic Aviation is investigating de Havilland's Gyron engine as a possible powerplant for NATO versions of its F-105 fighter-bomber. USAF versions are powered by a Pratt & Whitney J75.

► **Several companies are competing in an Army design competition for a helicopter transmission analyzer. Theoretically, analyzer will warn of any impending transmission failure to allow longer periods of use between overhaul and provide a safety factor so that transmission can be used on an emergency basis after it is due for overhaul.**

► Hycon Manufacturing Co. has developed equipment for USAF for detecting and recording data from the operation of rocket and turbojet engines at relatively long distances.

► **Thrust of de Havilland's Spectre rocket engine can be boosted from its announced thrust of 8,000 lb. to 10,000 lb. with minor modifications. Spectre will be produced as constant thrust assisted takeoff unit for the Avro Vulcan and Handley Page Victor bombers. Valiant bombers are equipped with Super Sprite units.**

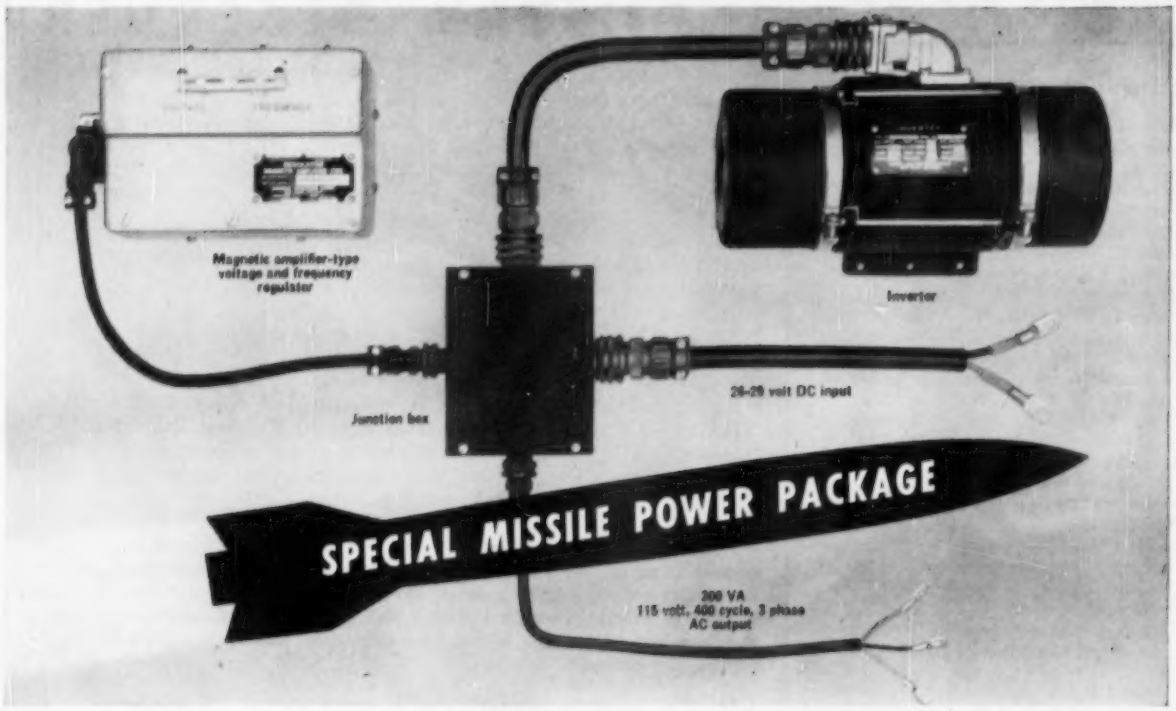
► Vertol's tilt-wing VTOL probably will make its first free flight this week or next if the company maintains its present schedule. Taxi and tethered hovering tests have been made in open at Philadelphia's Municipal Airport.

► **Rolls-Royce and Vickers Armstrongs are collaborating on a new vertical takeoff aircraft that is an outgrowth of Rolls' Flying Bedstead development.**

► Air Force has awarded Republic Aviation an additional $10 million to continue the test program of its F-105 fighter-bomber.

► **Recent Army tests employing H-34 and Bell H-21 helicopters to transport the Little John ground-to-ground missile at White Sands, N. M., were hampered by altitude-density of the area and darkness. Army is now recommending that pilots be provided data on loss of lift due to high temperatures and calling for better night-operation techniques.**

► Royal Canadian Air Force crews have taken delivery of its modified Comet IA jet transports equipped with de Havilland Ghost engines. Modifications, although costly, increased basic weight by only 500 lb. and improved high speed handling characteristics.



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Type	Input		Rated Output			Max. Altitude at Rated Output	Approx. Wt. Lbs.	Designed to Gov't. Part No.
	Volts	Amps.	Volts	Phase	VA Rating			
12128	27.5	1	26	1	6	35,000	2.2	AN3496
12126	27.5	2	26	3	10	35,000	2.3	E1615
32B21	27.5	3	115	1	20	50,000	5	—
MG-93	27.5	12	115/200	1 3	100 100	65,000	10	E5134
MG-54	27.5	22	115/200	1 3	250 250	50,000	17	E5109
12142	27.5	22	115	1 3	250 250	35,000	13	E1617
12143-1	27.5	22	115	3	250	35,000	13	—
12143-2	27.5	22	115	1	250	35,000	13	—
*32B15	27.5	22	115	3	300	50,000	14	—
32E01	27.5	35	115	3	500	50,000	26	AN-3533-1
32E00	27.5	51	115	1 3	500 750	50,000	34	AN-3534-1
MG-65	27.5	52	115/200	1 3	750 750	50,000	35	E52805-2
MG-61	27.5	126	115	1	1750	50,000	54	53C6767
1518	27.5	126	115	1 3	1500 1800	20,000	37	—
32E06	27.5	160	115/200	1 3	2000 2250	50,000	56	E1725
32E03-3	27.5	150	115	1	2500	50,000	58	53B6227
*32E03-8	27.5	160	115	1	2500	50,000	65	53B6227
*MG-77	27.5	150	115/200	3	2500	50,000	65	—
*32B49	27.5	160	115/200	1 3	2500 2500	50,000	65	E54807
MG-81	27.5	160	115/200	1 3	2500 3000	50,000	61	E1725
MG-95	27.5	160	115/200	1 3	2500 3000	50,000	58	E54807
32E09	27.5	160	115	1 3	2500 3000	50,000	60	—
32B27	27.5	285	115/200	1 3	3500 4000	50,000	76	—

*These inverters have magnetic amplifier "static" type voltage and frequency regulators.
NOTE: D.C. Input Voltage shown is nominal value of 27.5 volts, but all units are designed for 26 to 29 volt operation. Input amperes shown are rated at 27.5 volts input.

Red Bank DIVISION

Bendix AVIATION CORPORATION

Washington Roundup

Soviet Missile Threat

Soviets could launch effective strikes against the majority of U. S. troop concentrations and airfield complexes in the Far East from missile bases they are believed to be building along Peter the Great Bay near Vladivostok. From these sites, intermediate range ballistic missiles—which the Russians have tested in quantity—could blanket Japan, Okinawa, Iwo Jima, South Korea and a large portion of Formosa. Lone major U. S. Far Eastern complex outside the 1,500-mile range is in the Philippines. Mere presence of missile sites also could be used as a Soviet "big stick" to force Japan away from its foreign policy alignment with the U. S. Most of Peter the Great Bay has been closed to foreign ships and aircraft since July 20 despite U. S. protests that much of the area lies in international waters.

U.S.-Soviet Satellite Meet

U. S. National Committee for the International Geophysical Year is considering plans for a meeting here early in October at which Soviet and U. S. scientists could exchange views and air problems of satellite and other IGY research programs. Russians so far have been more close mouthed about their satellite program, following Soviet pattern of announcing only successful ventures and saving the embarrassment sometimes caused by announcement of goals that later are not reached.

Army Coup

Some Air Force observers, amazed at publicity Army has received through garbled press reports on flights of its missile test vehicles, are wondering if USAF shouldn't name its Lockheed X-17 test vehicle the "Atlas A" or "Thor I."

Latest Army coup was newspaper story saying Jupiter had "scored a major technical breakthrough in long-range ballistic missile development with the first conquest of the 're-entry' problem." Facts are that the vehicle was not a Jupiter but a test vehicle, and this was not the first conquest of the re-entry problem.

X-17 nose cones had survived re-entry many times (AW Aug. 12, p. 69) before Army test vehicle was fired. One account of the recent Army firing said the rocket traveled 12,000 miles. More accurate accounts said 1,200.

Military Pay Raises

Indications of congressional opposition to the plan to reshuffle the military pay system, giving new compensation incentives for merit and skill, developed during testimony last week by Ralph J. Cordiner, before a Senate Armed Services subcommittee. Cordiner, president of General Electric Co., headed the Defense Advisory Committee on Professional and Technical Compensation which made the proposal (AW Feb. 4, p. 37).

Senators raised the question that under the Cordiner plan the military services may be confronted by these alternatives: an imbalance of high-ranking officers or a wholesale firing of low and middle-ranking officers. Two points developed by Sen. John Stennis (D.-Miss.), chairman of the subcommittee, and Sen. Harry Byrd (D.-Va.):

• **14,989 colonels** (or equivalent rank) out of the total 12 million men in the armed services in mid-1945 compares with the present 14,213 of this rank out of a total of only 2.8 million men now in the armed services.

• **Under the Cordiner plan,** Army and USAF lieutenants would receive no pay increase. For higher categories the increase, as a percentage of present salary, would mount upward: captains, 1%; majors, 12%; lieutenant colonels, 31%; colonels 42%; brigadier generals, 38%; major generals 39%; lieutenant generals, 49%; generals, 57%. Cordiner said the incentive for the low ranking officers to stay in the service would be the prospect of rapid promotion for ability. Stennis plans to give comprehensive consideration to revision of the military pay system immediately after the convening of the new session next January.

Pilot Survey

First limited survey indicates USAF's tightening of pilot training programs may have the desired effect. Until recently, pilots spent three-quarters of three year hitch in costly training, served too little operational time to be of much use and then returned to civilian life in great numbers (AW Aug. 19, p. 25).

New order affects only new trainees, fledgling pilots in first four months of training and Air Force ROTC members. Survey among 310 trainees in first four months of training showed that 144 will quit rather than sign for five years, 166 will continue program.

'Constructive Contribution' Out

Long standing requirement that military information must "constitute a constructive contribution" to Defense Department's mission in order to be releasable has been abolished, but Assistant Secretary of Defense for Public Affairs Murray Snyder says basic "meaning and intent" of Pentagon information policy remains unchanged. Nevertheless, new directive (5230.9) was hailed as a "positive step" by House Government Information Subcommittee Chairman John E. Moss (D.-Calif.). Although it requires review for defense policy and national government policy as well as for security, it also reflects this positive attitude: "Nothing in this directive shall be deemed to authorize the refusal to clear material, otherwise releasable, because its release might tend to reveal administrative error or inefficiency."

Civil Aviation

Outlook is that at least two measures to assist local service carriers with their re-equipment financing will be enacted by Congress this session. These measures:

• **Authorize Civil Aeronautics Board** to grant a government guarantee of 90% on loans up to $5 million to local domestic, Alaska, and Hawaii lines for the purchase of equipment. Two U. S.-Alaska carriers—Alaska Airlines and Pacific Airlines—and two Caribbean carriers—Caribbean Atlantic Airlines and Mackey Airlines—also would be eligible. Measure passed the House 240 to 94 after being approved by the Senate 72 to nine. Only issue between the House and Senate versions is whether metropolitan helicopter lines also should be included, as provided by the House.

• **Encourage Financial Institutions** to offer financing by granting them rights over the aircraft equipment financed in case of bankruptcy. Measure has been approved by both House and Senate Judiciary Committee.

—Washington staff

Industry to Get Key Missile Logistic Role

Air Materiel Command's 10-year program will tie industry to world-wide communications system.

By Claude Witze

Wright-Patterson AFB, Ohio—Air Materiel Command's 10-year program to provide logistical support for USAF missile units calls for increasing participation by industry.

Weapon system prime contractors and the makers of vital components will be tied into a new world-wide communications system that will feed both data and hardware to the Weapon System Support Manager. (AW Aug. 19, p. 26).

As outlined by Maj. Gen. Kingston E. Tibbetts, AMC director of plans and programs, improvements and additions to the management picture in the next decade will include:

- **Truly global logistical command** organized along weapon system support lines.
- **High speed communications system** for the rapid transmission of logistical information.
- **Electronic data processing** capability to provide timely and effective internal management and the fastest possible reaction to customer demands.
- **High speed transport capability** to complete the dynamic cycle of the logistic system response.

Assignment of support responsibility for a dozen early missiles to five Air Materiel Areas, accomplished this summer, was the first step in a program to establish a stateside system of Weapon System Support Managers to deal directly with combat units anywhere in the world.

Next step, it is anticipated, will be a communications network linking the WSSM to its customers. In addition, the WSSM will be supported by industry through extensions of the communications system.

"There will be communications links," Gen. Tibbetts promises, "to all the elements of the logistical system, both military and industrial, that provide the support manager the resources for maintaining his weapon. These communications nets will be designed and employed for the purpose of transmitting logistical type of information."

Long-Range Program

Consultation with prime missile contractors and representatives of the Aircraft Industries Assn. already has been started to work out a long-range program for selection and installation of the equipment necessary to do this job. Not all of the transmitting and data processing machinery has been developed, and the manufacturers of this equipment still face a new challenge in AMC's 10-year program.

One paradox in the situation may be that the industry will install this equipment and take part in the AMC logistics program at its own grass roots level, at least partly to help USAF save money. And the economy will be realized from a reduced volume of weapons and spare parts.

Reduced Stockpiles

Drastically reduced stockpiles will come in with full-scale missile warfare. The specialized supply depot and the overseas depot will be phased out of the picture.

Gen. Tibbetts has explained the situation in terms of the smaller missiles:

Missiles in the GAR family—such as Falcon and Sidewinder—have more than 5,000 parts which must have constant "go" or "no go" checks that result in replacement of faulty minor, sub-assemblies.

"The biggest task," says Gen. Tibbetts, "is to keep the central system poised to immediately replace a malfunctioning missile with a good one and bring the sick bird back to a general hospital for treatment.

"Why not gear up to fix these sick birds on the spot and save all the rushing back and forth? Because a set of tooling and test equipment for this major surgery runs just over $2 million. We can't afford that at every fighter base.

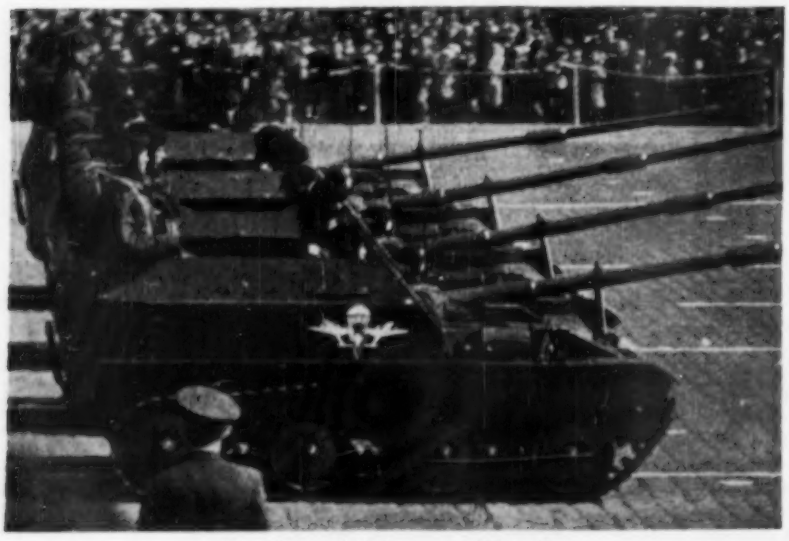
"Then why not build a few hundred extra birds and give each base a few spares so we can move at a more leisurely pace in hauling the little package back and forth? Dollars again provide the answer. . . . We must buy as few as we can and keep the down time to an absolute minimum."

In the case of the monster IRBM and ICBM types, AMC proposes to bring major tear-down equipment forward to the launching site. Only components will be evacuated for overhaul and modification. Again, the basic objective will be to buy as few as possible and keep even the supply of spares down to a level that will insure new economies.

Secret of the system will lie in improved communications, faster processing of data and high speed delivery, all the way from the manufacturer's plant to the combat-ready unit.

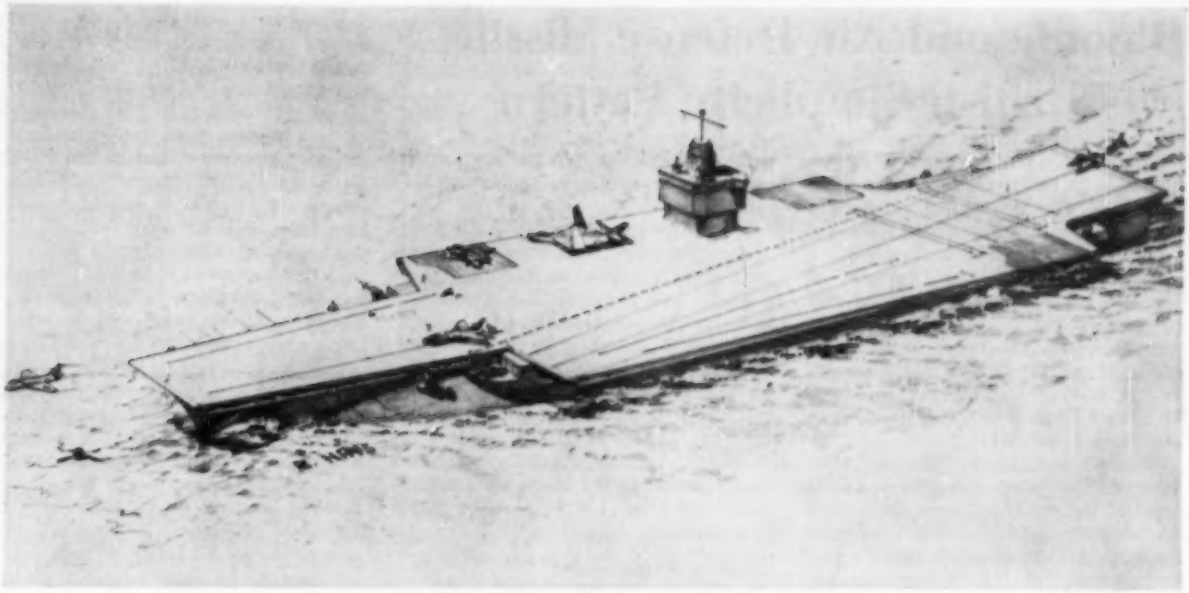
A great deal of the planning for this logistic creation may come from the Logistics Laboratory of the Rand Corp. in California, where the staff today is conducting simulated exercises and figuring out what speedups are needed in mechanical brains, punched card techniques and transportation.

The transport service will not call for



Soviet Airborne Tanks

Airborne tanks of the Red Army are paraded publicly in Moscow. They are armed with a 57 millimeter high velocity gun and can be dropped by parachute or airlifted in new Red Air Force turboprop assault transports such as the An-8 and An-10 and in large helicopters such as the twin rotor Yak-24. Note the parachute-airplane insignia on the side.



Navy's First Nuclear Carrier

Navy's first nuclear powered carrier will have a 74,700 ton standard displacement, 1,088 ft. length, 133 ft. hull beam, 4,000 sq. ft. more deck space than USS Forrestal and 2,000 sq. ft. more hangar deck space. Newport News Shipbuilding and Drydock Co. of Newport News, Va., will begin building it this fiscal year. Cost will exceed $300 million. Eight reactors in tandem pairs will power four screws and top speed will be about 33 knots. CVA(N)-1 will be able to conduct air operations for at least 8 days, compared to 3-5 days for conventional carriers, before escort ships become nuclear powered, and for 12 days or more after that. Elimination of stacks allows installation of a new high-performance radar which will give vastly greater detection range and is harder to jam. Lack of stacks also decreases chance of infrared detection, cuts corrosion and damage control problems, crew discomfort. Navy's Fiscal 1958 program also includes construction of six guided missile frigates, three large nuclear powered missile submarines, five missile destroyers and conversion of three cruisers to carry missiles.

heavy lift as much as it will for high frequency. In today's stable, aircraft like the Lockheed C-130 and Douglas C-133, running with something that approaches street-car service, probably would be able to answer most of the demand.

As electronic data processing is improved, and experience provides better provisioning material, it is contemplated that spares requirements for a particular combat unit or the storage site of a Weapon System Support Manager can be anticipated and stores put in the pipeline without a requisition spelling out the needs.

Major problems in perfection of this system lie, of course, in the unpredictability of the demand and the seemingly-constant high pace of technological change. An integrated data system that will "think" about these factors and make allowances for them will be a major achievement for AMC management.

Gen. Tibbetts says the Weapon System Support Manager must have a data processing system that will receive, digest and analyze all logistical information from all over the world. He anticipates that the WSSM will be able to find out how many he needs of any and all items, turn this into a dollar budget, find out how much warehouse space is needed and where, how many people are needed and what transportation is required for any program in his field of missile responsibility.

Mixed Inventory

He should be able to determine all this in about a week. In addition, if a change is ordered in the program, he should be able to find out quickly how feasible the change is in terms of money and manpower required.

Newbury's Successor

As predicted by Aviation Week (AW Aug. 5, p. 25), Washington research consultant Paul D. Foote has been nominated to succeed Frank D. Newbury as Assistant Secretary of Defense for Research and Engineering.

A former executive vice president of Gulf Research and Development Co., Foote has maintained his own consulting firm in Washington since 1953. Newbury left the post after controversy over his attitude toward research and development (AW April 29, p. 27).

Foote, who made his initial appearance late last week before the Senate Armed Services Committee, also has been serving on the National Research Council of the National Academy of Sciences.

Gen. Tibbetts and his staff are mindful of the fact that USAF will have a mixed inventory—missiles and manned aircraft—for some years to come and that the transition to a new system must provide adequate support for both types of weapons in the intervening years. For this reason, the changeover already has been started on the Century Series fighters.

Says Gen. Tibbetts:

"The different nature of our tasks that will stem from this new family of weapons is determined basically by a single fact—a missile, whether it is large or small, is an unmanned aircraft.

"It has all the components: an airframe, a propulsion system, a guidance system, provisions for carrying a destructive device and an array of ground support equipment.

"All these systems have changed so radically, however, that the principals of logistically supporting manned aircraft weapon systems must be drastically modified."

It probably is true that aside from the impending revolution in manufacturing techniques, the most drastic changes that lie ahead for the aircraft industry will result from its integration into the AMC logistic complex on a scale that was considered impossible and impractical before the missile era.

Bloodhound Air Defense Missile Fits British Simplicity Pattern

London—Bristol-Ferranti Bloodhound, a ground-to-air semiactive homing missile now in quantity production for the Royal Air Force, was displayed last week by Bristol Aeroplane Co.

Bloodhound, a winged missile, is boosted by a nest of four solid fuel rockets and sustained by two Thor type ramjets, phased to come in with full power at speeds in excess of 1,000 mph. It has a wing span of 111 in., body length of 22 ft. 2 in., and principal diameter is 21 in.

Bristol was responsible for the structure and the power units. D. J. Farrar, head of the structural team at Bristol's Filton plant, explained that the missile wings have variable incidence, are used differentially to roll the missile and move together in pitch. "Decision to use this control system stems from its superior response characteristics," he said.

Thrust Estimate

Some experts deduce the ramjet thrust based on frontal areas and a gross weight quoted officially at "around 2,000 lb." to be of the order of 8,000 lb. for each engine and fuel consumption equivalent to that of a 20,000 lb. thrust turbojet. Speed of the missile is reputed to be Mach 2.5-3.

All the instrumentation was switched off during demonstrations of the ramjet motor in the test house which was laid out to show the outstanding response of the engine to savage throttle pumping over its whole working range.

Although only two components of the whole missile were shown, one was of considerable interest. A ram air driven turbine 20 hp. hydraulic pump powering the missile servos expands air at 1,500 psi. through reaction turbines rotating at 32,500 rpm. The turbines drive a four bladed, single stage, open hydraulic impeller, the shroud of which rotates—solely through viscous drag—at half the impeller speed. This reduction of relative speed between the impeller and the shroud reduces viscous losses, hence pump size. Pressure at outlet front impeller is 20 psig. The rotating shroud principle is a National Gas Turbine Establishment development.

The other component was a "Thor T type" fuel pump which has a rating of 45,000 lb./hr. at 30,000 rpm. and a delivery pressure of 800 psi. Ram air drives a single stage impulse turbine.

All gyros in the control system coast after launching.

What could be observed from the missile display confirmed the "essentially practical down-to-earth approach using simple hardware" policy of the company.

Double wedge wings have a diamond plan configuration with the tips snipped off obliquely spanwise. Leading edges are solid and the thin skin profile stabilized with non-metallic filler. Fixed double wedge rectangular planform tail surfaces show similar construction. Hollow metal rocket fins are stabilized with laminated wood. Earlier fins appear to have been made largely of wood.

All the materials, which include some stainless steel in the body, are commercially available. There are no nimonic type metals.

Sliding Attachment

The boost rockets are hinged at the bottom from a common ring which freely locates the tail of the missile body. On separation, the rockets part outwards from the forward attachment point and fall behind with the seating ring intact.

The ramjets appear to have a single forward attachment point and to be located at the rear by a sliding attachment allowing almost half an inch thermal axial expansion.

External bolt ring observable towards the nose probably marks the quick marrying joint where the body and warhead come together.

The company mentions a threefold preference for the ramjet over the rocket:

- **Above 20 miles** range, weight increase with range grows rapidly in its favor.
- **Falling drag** with falling thrust characteristics ease the control problem of variable altitude operation.
- **Offers a wide band** of altitude and range conditions and a flexibility to suit all types of targets.

The Ferranti organization developed the highly classified early warning radar control and guidance equipment. It claims this work represents 40% of the entire project. Extensive use is apparently made of printed circuitry which this 12,000 employe organization—the largest guided missile work force in Europe—claims to have pioneered in Britain. Five Ferranti plants around Britain are heavily engaged on this and other missile projects. The company also claims to have installed the most powerful vibration equipment in Europe for environmental testing.

The transporter is extremely simple and when loaded is pulled by a Land Rover—the British Jeep. With wheels removed it acts as the launching platform.

Bristol points out that though it was the last contractor to enter the guided missile field in 1949, it has been the first to develop an acceptable system. This is attributed to the valuable turbojet data received from Boeing under an exchange agreement and to the immediate availability of over 26,000 hp. compressor plant in its engine division. Free jet tunnels are used.

The Bloodhound system is based on long range early warning radar locating the target, automatically informing a second tracking radar system which lays a narrow beam on the target. The missile sees the reflections and, aimed in roughly the right direction and launched automatically, computes and implements its own optimum interception course independently of all ground based computation.

When pressed to compare the missile with current U.S. weapons, the company said it came closer to Nike, was superior to it on a time scale but whether reference was being made to Ajax or Hercules was not clarified.

Bloodhound is being offered to all NATO and Commonwealth countries on a government to government basis. "But any government would have to show a positive commitment before it got significant details or a demonstration firing," a company official said. In view of intense U.S. competition, the company believed this would be its greatest handicap. The company said it has been informed unofficially that Nike is being offered "free" to NATO countries.

IRBM Weapon Dispute May Run Until 1958

Washington—Evolution of a single land-based intermediate range ballistic missile from the Army Jupiter and Air Force Thor programs will involve test firings running at least into next year.

Defense Secretary Charles E. Wilson described his appointment of a three-man Jupiter-Thor committee (AW Aug 19, p. 30) as an attempt to "see if the technicians couldn't agree on a technical basis aside from the pressure of service ambition on the best result for the country, best thing to do."

Members are Wilson's special assistant on guided missiles, William H. Holaday; Maj. Gen. John B. Medaris, chief of Army Ballistic Missiles Agency, and Maj. Gen. Bernard A. Schriever, chief of USAF's Ballistic Missiles Division, ARDC.

Although there is some feeling that nose cone and guidance of the Jupiter may be salvaged from the Army program, Pentagon observers view the committee as a polite way of finally phasing the Army out of the IRBM program.

Wilson said there will be a broad

decision within a month or six weeks as to what further will have to be done to evolve a single missile, but "there's just lots of detail work to do even after a decision is made what the end result should be." He said Army's Redstone Arsenal "will have money to complete the number of missiles and the testing of them that's determined after this review that's going to be made by this committee."

Firings of both missiles will run into next year, he said.

Wilson said the ABMA-Redstone Arsenal complex at Huntsville, Ala., probably would continue to employ "just as many or more than before they had the Jupiter development started." He said he thinks Army "can develop a much better 200 mile missile than they have now."

Asked if the Army hopes to have a missile "of any range in that 200-mile plus area that they can move," Wilson said "that would be a proper objective, for them to have as flexible and as small a missile as would do the trick and it ought to be accurate also." Army is working on this, he said, but "it's not in a very active stage yet."

U. S. Leads Russia On IRBM: Brucker

San Francisco—United States is ahead of Soviet Russia in the development of a 1,500 mi. intermediate range ballistic missile, according to Secretary of the Army Wilber M. Brucker. Brucker expressed this view here prior to addressing the West Coast Electronic Manufacturers Assn. and visiting Army missile and electronic contractors in the Bay area.

Brucker said Army's Jupiter IRBM is "slightly ahead of schedule," but declined to discuss relative merits of Jupiter and USAF's Thor IRBM in view of Defense Secretary Wilson's recent action in setting up a three-man committee to resolve competing programs into a single IRBM effort. Brucker said committee's report, expected in 30-60 days, will recommend a "plan whereby the best missile can be selected," and will not in itself name the winner.

Army plans "no substantial missile cutbacks on the West Coast," Brucker said, but indicated such action might be applied to Army missile programs elsewhere.

Avionics will play a major role in any successful defense against enemy intercontinental ballistic missiles, Brucker told the association. Such defense will require detection and computing systems which can collect and correlate great amounts of precise information almost instantaneously, then accurately guide the counter-missile.

"The counter-missile must be on its way in seconds, aimed with pinpoint accuracy to intercept the ICBM at unprecedented altitudes, speeds and ranges once the missile is detected," Brucker said. "There will be no time for human judgment to be brought to bear, therefore human judgment must be designed into the system in advance."

Brucker predicted that missile and extremely cheap drones will replace piloted aircraft for reconnaissance missions over combat areas, in the not-too-distant future because manned aircraft will be too vulnerable to ground fire.

Troubles Boost Vanguard Cost

Washington—Additional $34.2 million requested by Navy from Defense Department funds for completion of Project Vanguard was made necessary partly by developmental troubles with first and second stage engines and the satellite launching vehicle itself. All three now have been corrected.

Rear Adm. Rawson Bennett, Chief of Naval Research, explained to a House subcommittee that only three things can be adjusted "whenever you run into any kind of trouble in a development project"—money, time and performance.

Solution With Money

"We are not at liberty to change either the time or performance, so we have to use money to get out of trouble."

The troubles were:

• **General Electric Co. first-stage** engine. "It seemed to burn out," Adm. Bennett said. ". . . The real answer was quality control; the nozzles, the injectors and other items were not being accurately enough made so that unusual heats, that is, local heat spots in the engine, would be prevented. Once that was realized and corrected, the first-stage engine was on the beam."

• **Aerojet-General Corp. second-stage** engine. This engine "was in a similar sort of trouble," Adm. Bennett said. "The source or reason for the trouble was also unknown. It eventually turned out to be a somewhat similar type of defect and was corrected."

• **Martin Co. launching vehicle.** "The structural trouble was the computational suspicion that vibration, etc., would set in within the vehicle frame," Adm. Bennett said. "This was eventually ironed out but at considerable time and expense for recomputation and re-engineering. We did not lose any particular fabrication time or energy, only the money in correcting the defect."

Total Cost

Total estimated cost of the Vanguard program, including the $34.2 million, is $110 million. Capt. A. B. Metsger, Deputy Chief of Naval Research, told the Senate Appropriations Committee that "if we do this by the end of 1958 for $110 million, this will be the quickest and cheapest rocket project that has ever been seen, and I think we may well do it. This is a bargain-basement job."

Adm. Bennett cited two other factors contributing to rising Vanguard costs, which Rep. George H. Mahon (D.-Tex.) said had "ballooned heavenward to a pretty high point:"

• **"When the scientists discovered** that they could not just simply take items off the shelf, put them together and have a successful satellite."

• **"When the detailed specifications** were written, and for the first time everyone realized the full implications of the development work involved."

Martin Co., prime contractor on an installment type cost plus fixed fee contract, has estimated committed costs to date to be $47,581,000, Navy said. Original estimate in March, 1956, was $28,649,000.

Test Program

Other highlights of the Navy testimony:

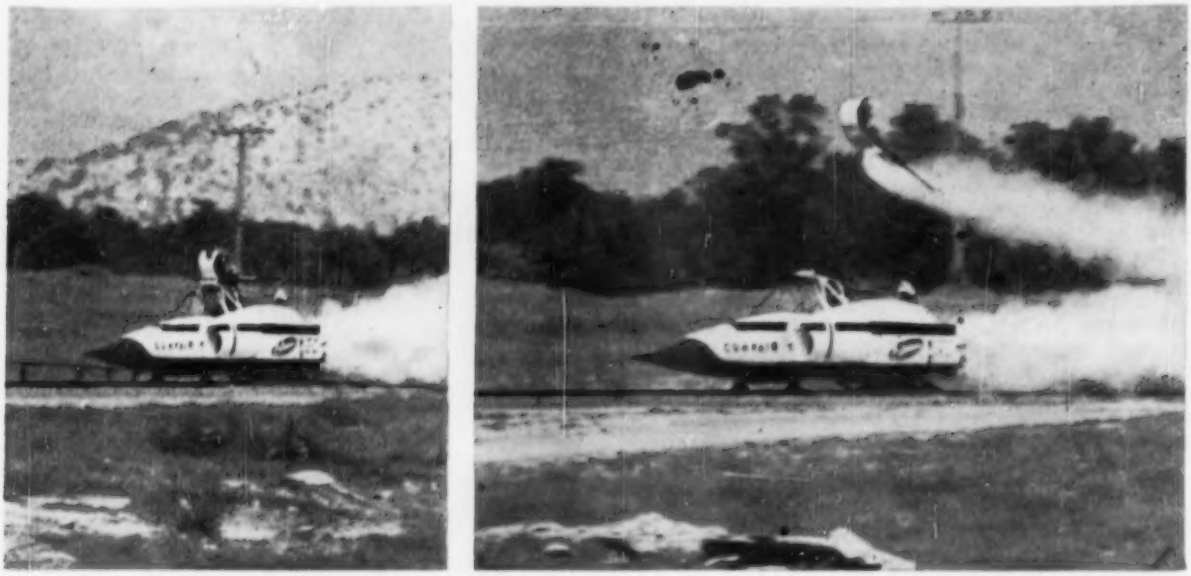
• **Second test firing** last May, using a Viking rocket plus Vanguard third stage prototype, "proved beyond a shadow of a doubt the essential soundness of the design for separation and spin stabilization of the Vanguard third stage." Adm. Bennett also said proving the fact "that the rocket would ignite and burn satisfactorily at this altitude (was) successfully accomplished."

• **First Minitrack station,** now in operation at Blossom Point, Md., "has been receiving signals from celestial bodies since last fall. This station recently picked up signals from the moon."

• **Some Vanguard rocket** instrumentation and the Minitrack transmitter "performed successfully" in the first test firing last December, using a single stage Viking rocket.

• **Total of two Vikings** and five Vanguard test vehicles will have been fired before first of six Vanguard launching vehicles is fired (see p. 86).

• **Instrument packages** for first few satellites now are fairly firm. Package I will include devices for measuring atmospheric environment and solar ultraviolet radiation. Package II will measure cosmic rays. Package III will measure the earth's magnetic field and aerodynamic drag on the satellite. Package IV will be either a meteorological experiment or investigation of the earth's radiation balance.



B SEAT, designed for supersonic ejection and newly equipped with twin stabilizing booms, poised for launching from supersonic sled duplicating Convair F-102A cockpit (left). Split second later, B seat separates under own rocket power (right).

Booms Stabilize Supersonic Escape Seat

New B seat for supersonic ejection that substitutes telescoping booms and fins for stubby rudders and horizontal stabilizers (AW May 6, p. 94) to eliminate a roll-yaw coupling motion encountered with the old-model seats has shown excellent stability characteristics during tests on a supersonic track.

B seat, developed for USAF's supersonic Century series fighters, stems from work done by the Industry Crew Escape Systems Committee. Convair (San Diego) is chairman of the 13-member committee of aircraft companies and subcontractors who work with Air Research and Development Command to perfect a safe ejection system for supersonic aircraft.

Tests are being conducted at ARDC's Supersonic Military Air Research Track, Hurricane Mesa, Utah, by Coleman Engineering Company, Inc.

On the first successful test, a full-scale dummy-seat combination was mounted on a Convair F-102A cockpit sled in a knees-to-chest, feet-first, supine position.

Seat was ejected by rocket from the sled while it was traveling at supersonic speed.

Seat rose almost 300 ft., sailed smoothly clear of the mesa's edge, and floated safely to the canyon floor 1,500 ft. below on a parachute which had been deployed at the proper moment. Dummy and seat were undamaged.

Convair technicians say that dummy was subjected to an acceptable 10G acceleration by the seat's rocket and windblast deceleration was "quite low, well within the limits of human tolerance." Average chest pressure was exactly half that to which a pilot, ejected in the normally upright position in a conventional seat, would be exposed, Convair said.

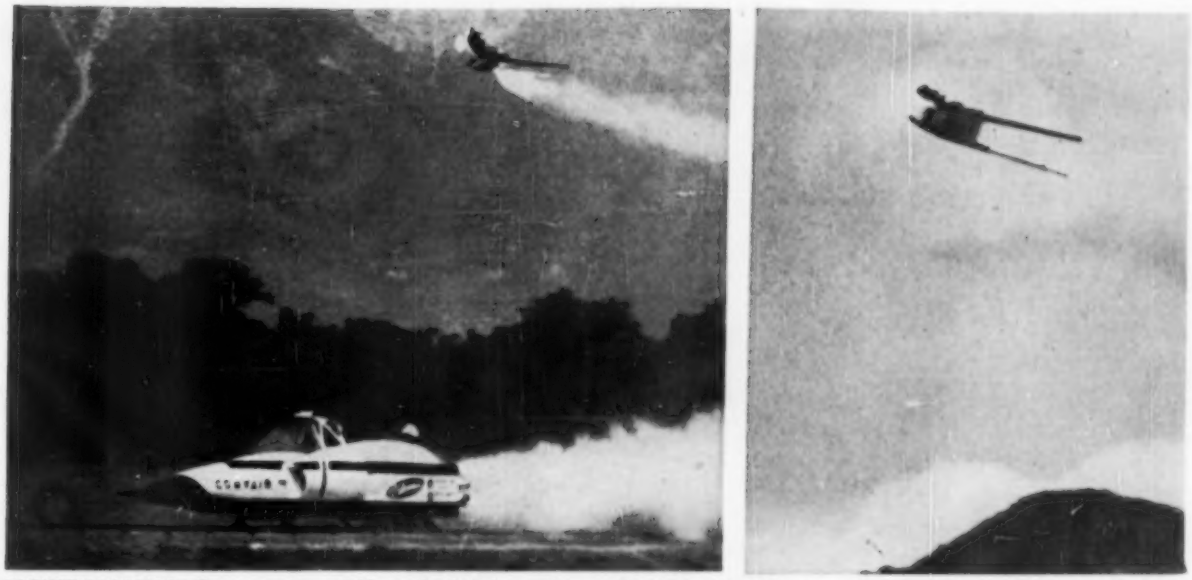
In the first half of its trajectory, the boom-equipped B seat made only a quarter of a turn. Complete 8,000-10,000 ft. flight was made with only a half-turn. Main objective—an aerodynamically stable seat—has been achieved.

The twin booms with fins at the back serve to stablize the seat much in the same manner as an elongated fuselage, which supports an empennage, stabilizes a plane.

The booms telescope into four sections each for stowage in a small space. They are extended by internally carried explosive cartridges. The fourth, or tip, section of the booms contains spring-actuated fins which pop out as soon as the fourth sections of the booms are positioned.

Next tests, to be conducted this fall, will simulate the complete ejection cycle of rotating the seat to the supine

CLOSEUP of new B seat shows dummy in supine, knees-up position and four-section, telescoping 5 ft. stabilizing booms, ends of which mount small steering fins.



ROCKET-PROPELLED B seat soaring quickly to the 300 ft. maximum altitude it achieved during test at SMART track (left). Shot at right shows seat at about midpoint of its 10,000 ft. flight. Seat has rotated 90 deg. from its launching axis.

position, extension of telescoping booms and fins and separation of dummy from seat.

ARDC assigned Lockheed Aircraft Corp. a parallel responsibility for developing a downward supersonic escape system.

Rohr to Hire 2,300 for Production of 707 Fuselage

Rohr Aircraft Corp. will hire 2,300 new workers by the end of the year to handle production of fuselage sections for the Boeing 707 jet airliner which will be transferred from Ryan Aeronautical Co. to Rohr.

Ryan announced that a new higher production rate to be reached on the KC-135 fuselages, together with heavier deliveries required on other major Ryan programs, will offset any reduction in work force.

Rohr confirmed that it has received an initial order for approximately $13 million from Boeing for 40-ft. fuselage sections.

A3Ds Fly Hawaii-U. S. Nonstop Without Refueling

San Francisco—Four A3D Skywarriors, returning from carrier qualifications, flew from Barbers Point, Hawaii to a point over San Francisco International Airport in times ranging from 4 hr., 12 min. for the first to 4 hr., 14 min. for the next two and 4 hr., 18 min. for the last.

A3Ds were first Navy turbojet planes to fly nonstop and without refueling on this particular route, according to spokesmen at Alameda Naval Air Station.

Firm's Right to Unexpected Profits Is Heart of GM Controversy

By Katherine Johnsen

Washington—A manufacturer's right to unexpectedly high profits under a fixed-price type contract is the heart of the controversy over an alleged $17 million in "excess profits" by General Motors Corp. on a $375 million Air Force contract for 599 F-84F jet fighter aircraft.

The charge of the excess profit was made by General Accounting Office in a comprehensive report and picked up by the House Armed Services Investigating Subcommittee (AW July 29 p. 25).

The aircraft were produced at General Motors' Buick Oldsmobile-Pontiac Assembly Division, Kansas City, Kan., between 1951 and 1955.

'Phenomenal Job'

The main reason for the high profit, it was developed in testimony before the subcommittee last week, was that General Motors completed the third and final segment of the contract far in advance of the projected schedule. "They did a phenomenal job," Lt. Col. George W. Thompson, chief of Air Materiel Command's Pricing Staff Division, told the subcommittee. "They performed and earned the profit."

Maj. Gen. William T. Thurman, deputy director of procurement and production at AMC, emphasized that "it is of greater benefit to pay a contractor $2 of profit in an overall price of $10 than $1 of profit in an overall price of $11."

Percentage-wise, General Motors realized a profit of 11.3% before taxes, 5.4% after taxes. The three-segment contract was twice re-determined. Noting that the profit rate of the major airframe manufacturers averages only 3%, with a range from 2.14% to 3.68%, Subcommittee Counsel John Courtney said that the much higher profit on the General Motors contract attracted the attention of the subcommittee and General Accounting Office.

GM's Reply

John F. Gordon, General Motors vice president, strongly defended the corporation's performance and earnings and testified that he felt "no legal or moral responsibility for a refund of any part of the $17 million alleged excess profit."

Rep. Edward Hebert (D.-La.), subcommittee chairman, and Rep. Porter Hardy (D.-Va.) charged that at the time of the final re-determination in March, 1955, General Motors was aware that it could accelerate its schedule and complete the contract substantially before the planned wind-up in July.

The contract was finished in May. Air Force representatives acknowledged that all required sub-assemblies were at the Kansas City facility at the time of the March negotiations, and "it was

simply a matter of putting them together."

"They walked in with their bag loaded and how much they could keep in the bag was to their advantage," Hebert protested. He told Gordon that General Motors position was to "stay within the law, but to demand its pound of flesh."

Gordon strongly defended the fixed-price type of contract. "Experience," he said, "has demonstrated again and again that the fixed-price contract provides the greatest incentive for cost savings."

He explained that "due to the ironing out of production difficulties and the almost complete cessation of other delaying factors, we were able to complete deliveries three months ahead of contract schedules. While it was impossible to forecast these conditions, nevertheless it did result in our being able to make important cost savings through an earlier than planned reduction of the aircraft organization and costs."

Gordon noted that the unit price of the aircraft was successively reduced from $2,350,000 on the first segment, to $420,000 on the second, and $271,165 on the third. The subcommittee staff maintains that the price on the third should have been $254,073.

"Fixed price contracts are negotiated on the basis of estimated costs plus a bid profit rate," Gordon argued. "Once the fixed price is established the contractor has an incentive toward greater efficiency, lower costs and prices. This incentive is increased profit. The government receives the advantage of the lower costs through reduced prices in future price re-determinations and additional procurements." Referring to General Accounting Office's review of the contract after completion, he commented that "hindsight makes no provision for contingencies."

Navaho in Final Configuration

Final version of the North American Navaho, SM-64A, is slightly different from XSM-64 version, also known by company designation G-26 (AW Aug. 19, p. 29). SM-64A has three chamber instead of G-26's two chamber booster, single instead of twin vertical tail and trapezoidal rather than truncated delta canard control surfaces. Wing also is changed from truncated delta shape to a more elliptical shape with pointed tips.

Defense Warns of R&D Program Cuts

San Francisco—Defense Department official has warned that military services will show far greater selectivity in their choice of sponsored research and development programs, forcing changes in military and industry management techniques to provide tighter control.

Speaking before the Western Electronic Convention (Wescon), Benton H. Schaub, office of assistant secretary of defense for research & engineering, said that the prospect of an essentially fixed military budget level will not permit exploration of growing numbers of problems in military technology. Cost of increasingly complex weapon systems also will create pressures to divert funds from research and development, Schaub predicted.

Level annual rate of military appropriations will therefore "appear to be a substantial year-to-year cut in funding," in terms of the number of programs that can be sponsored, Schaub said, and he added a warning: "Our ability to manage our research and development programs is going to be crucially tested."

Because there will be fewer overlapping developments, both with respect to operational characteristics and time, Schaub said, failure to meet development objectives will leave a much larger gap in defense capability than before.

Schaub admitted that it is not as easy to measure progress and performance of scientific personnel in research and development as it is in production. However, he reported increased effort toward improving management of development and that there has been "notable success."

F-103 Nuclear Cuts

Washington—USAF has withdrawn support of Pratt & Whitney's nuclear engine project, and Atomic Energy Commission is considerably reducing its support. USAF last week also canceled the $100 million Republic XF-103 project and announced that North American Aviation, Inc. will develop an advanced strategic missile for the B-52 (AW Aug. 12, p. 23).

Joint USAF-AEC investment in the Pratt & Whitney nuclear laboratory is roughly $50 million. If AEC reduces its support too far, the company probably will attempt to drop the project altogether. USAF was not dissatisfied with technical progress, made the cut for budgetary reasons.

In canceling the XF-103 and its Curtiss-Wright J67 turbojet-ramjet engine, USAF blamed budget reviews plus promised availability of other research vehicles which will produce similar data.

Four Navy Aircraft Affected by Slowdown

Washington—Navy aircraft procurement slowdowns affecting four modern fighters and bombers were officially announced last week. In addition to the budget ceiling imposed by the Defense Department, Navy said rising cost and technological advances shared responsibility for the stretchouts. Aircraft on the list included:

- **Chance Vought F8U-1 Crusader.** Small reduction in current procurement and slowdown in planned production rate.
- **Douglas F4D-1 Skyray.** Schedule stretchout.
- **Douglas A4D-2 Skyhawk.** Curtailment and slowdown of deliveries.
- **McDonnell F3H-2N Demon.** Minor stretchout in delivery schedule.

No changes are contemplated in any of the Navy missile programs. This applies in general to Regulus I and II, Sparrow I, II and III, Sidewinder, Tartar, Terrier and Talos.

New A3D Versions

Washington—Photo reconnaissance and trainer versions of the Douglas A3D Skywarrior are in production at El Segundo Division (AW Aug. 12, p. 59).

A3D-2P will be the first jet designed exclusively for photo missions. A3D-2T will carry pilot, bombardier, instructor and six students, contain dual bombing system. Both use completely redesigned, reinforced, pressurized fuselage. A3D-2Q countermeasures version, not mentioned in Navy's announcement on A3D-2P and A3D-2T, also will be produced.

High Altitude Study

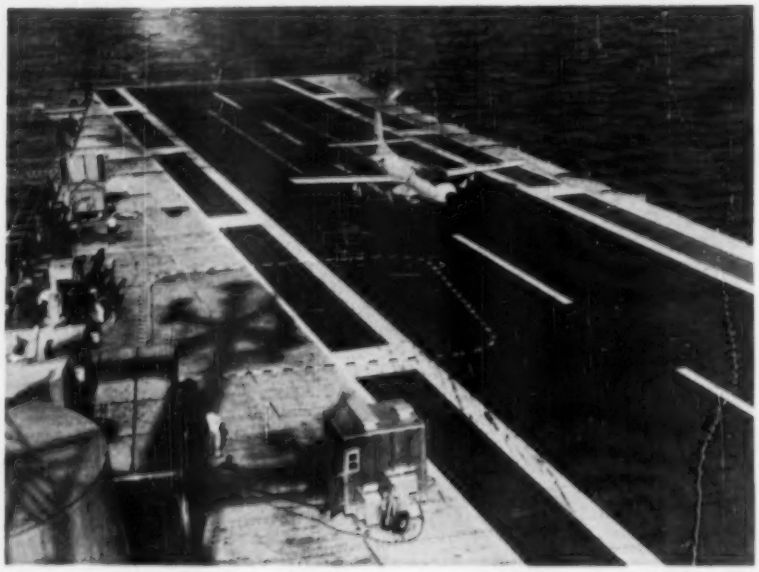
Maj. David Simons, Air Force physician attached to the Aero Medical Field Laboratory at Holloman Air Development Center, N. M., last week set a new altitude record for balloons at 102,000 ft. He was aloft over Minnesota for 32 hr. Purpose was to study physiological effects of lengthy high-altitude flights.

Other aircraft on the Navy procurement list also unaffected by the curb on Fiscal 1958 spending include the North American T2J-1 trainer, Grumman F11F-1 Tiger and the F9F-8T Cougar trainer. The latter Grumman aircraft will be ordered, Navy said, only in numbers sufficient to fill requirements. A new order was reported for an undisclosed number of F9F-8Ts.

Details on other Navy aircraft procurement plans were:

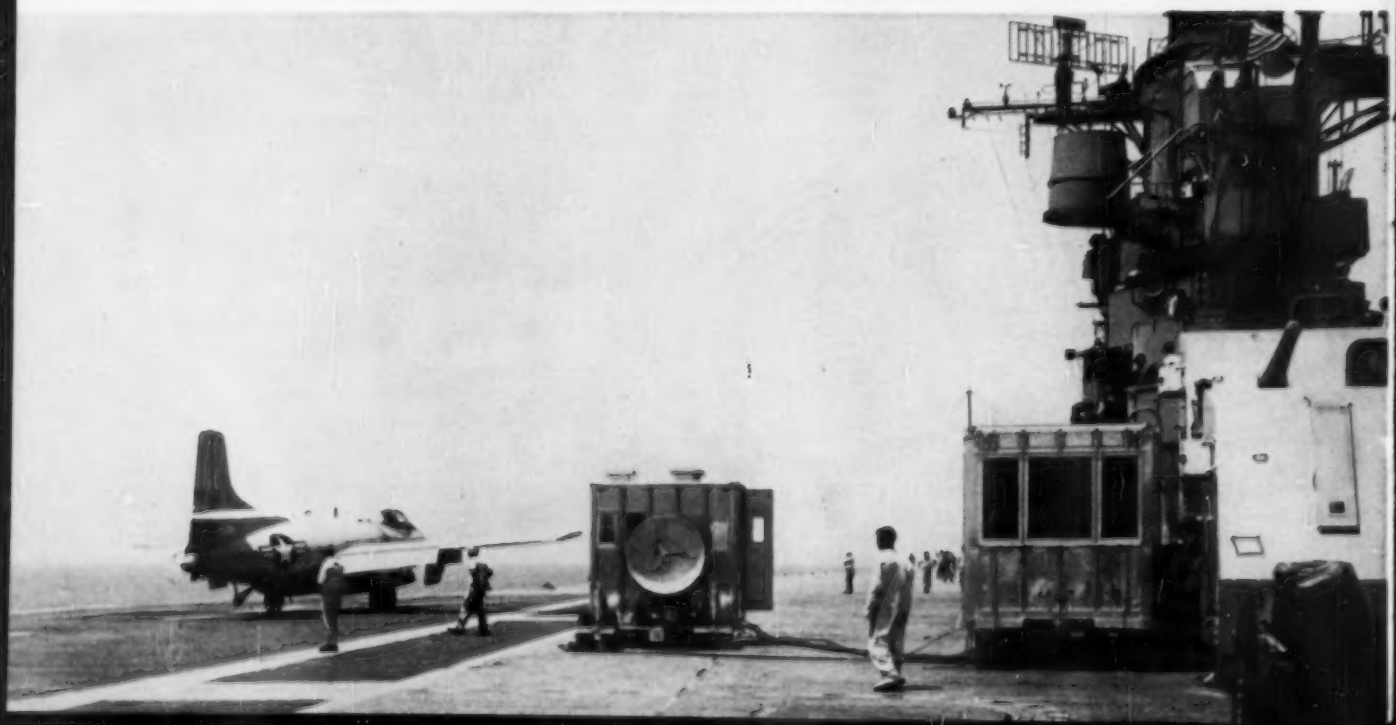
- **Douglas A3D Skywarrior.** Modifications are being installed and will have first flight tests early next year.
- **Douglas A4D-3 Skyhawk.** Contract terminated for four aircraft.
- **Grumman S2F-3 Tracker.** Small production quantity planned.
- **Lockheed T2V-1 SeaStar.** Trainer procurement was cut earlier in the year and no further changes are contemplated.
- **Lockheed W2V-1.** Program for this long-range early warning aircraft has been partially terminated.
- **Martin P6M-2 SeaMaster.** Small procurement cut announced in June, no further changes expected.

Navy spokesmen said overall effect of the cutbacks will not be felt in Navy inventory until next fiscal year or later. It was estimated that the original plan to buy 1,220 aircraft in Fiscal 1958 has been reduced to 1,025. First cut to 1,085 was made by Congress, the remaining 60 were deleted to meet the current financial emergency.



Automatic Landing Tested on Carrier

Automatic landing system developed by Bell Aircraft Corp. is tested by Douglas F3D Skynight aboard carrier Antietam in flight operations off Pensacola, Fla. Radar in system locates F3D to determine its altitude and position in relation to carrier deck. Then computer sends necessary course corrections to autopilot in aircraft and brings the airplane into touchdown with pilot virtually a passenger. Navy requires system land airplane within plus or minus 30 ft. longitudinally and plus or minus 25 ft. laterally of a pre-established landing spot on deck. Carrier Suitability Section of Flight Test Division at the Naval Air Test Center, Patuxent River, Md., is conducting tests. Guidance and control units can be seen (below).



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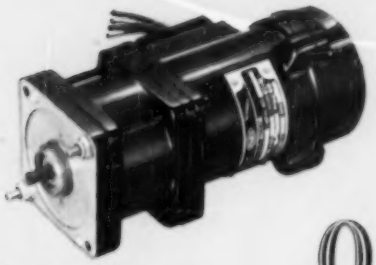

Type: C-1874 400 cycle 3 phase AC Motor and Clutch. **Weight:** 4.5 lbs. **Voltage:** 200 volts. **Output:** 650 watts. **Intermittent duty:** 12,000 rpm. **Meets Military Specification** MIL-M-7969A (ASG).

Type: D-638 400 cycle AC Motor. **Weight:** 17.5 lbs. **Voltage:** 200 AC, 20 amps at 6.5 hp. **Duty cycle:** 3.0 seconds at 6.5 hp, 15.0 seconds at 1.5 hp. **Maximum capacity:** 6.5 hp. **Continuous rating:** 5 hp at 2300 rpm, 15.8 amps, 200 volts. **Meets Military Spec.** MIL-M-7969A (ASG).

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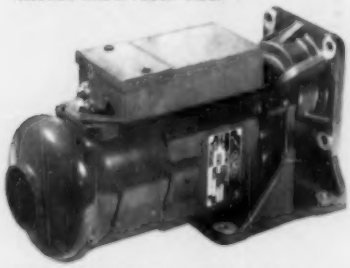
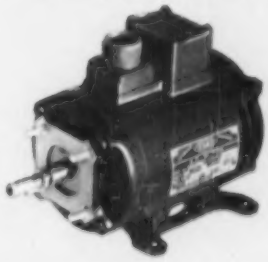
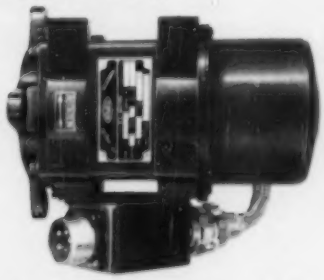


Type: D-751 DC Motor. **Weight:** 20 lbs. **Duty Cycle:** 5.2 hp at 2100 rpm (intermittent) on 26 volts DC; 3.5 hp at 2200 rpm (continuous) on 26 volts DC. **Meets Military Specification** MIL-M-8609.

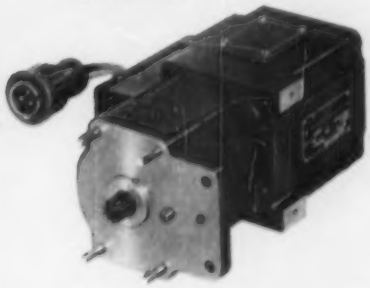


Type: D-800 400 cycle 3 phase AC Motor. **Weight:** 8.75 lbs. **Voltage:** 208 volts. **Horsepower:** 2.5 hp. **Continuous Duty:** 11,300 rpm; Equipped with thermal protector. **Meets Military Specification** MIL-M-7969A (ASG).

Type: D-899 400 cycle 3 phase AC Motor. **Weight:** 11.25 lbs. **Volts:** 200 volts. **Load:** 2.75 hp continuous output. **RPM:** 3140 rpm output at gear box. **Power factor:** 83%. **Overall efficiency:** 76% for entire unit. **Meets Military Specification** MIL-M-7969A (ASG).



Type: D-932 400 cycle DC Motor. **Weight:** With radio noise filter—13 lbs., without same—12.4 lbs. **Terminal voltage:** 27.5 DC plus or minus 1.5 volts. **Load:** From .5 hp minimum to 2.6 hp maximum. **Speed:** Continuous at 12,000 rpm, plus or minus .005%. **Speed Control:** By frequency regulator supplying control field. **Meets Military Spec.** MIL-M-8609 (ASG).



Type: D-927 DC Motor. **Weight:** 7.25 lbs. with 2-circuit noise filter for ungrounded systems. **Weight of filter:** 1 lb. **Terminal voltage:** 27 volts, 18 amps. **Load:** 0.5 hp. **Speed:** Continuous at 9900 rpm. **Meets Military Specification** MIL-8609.

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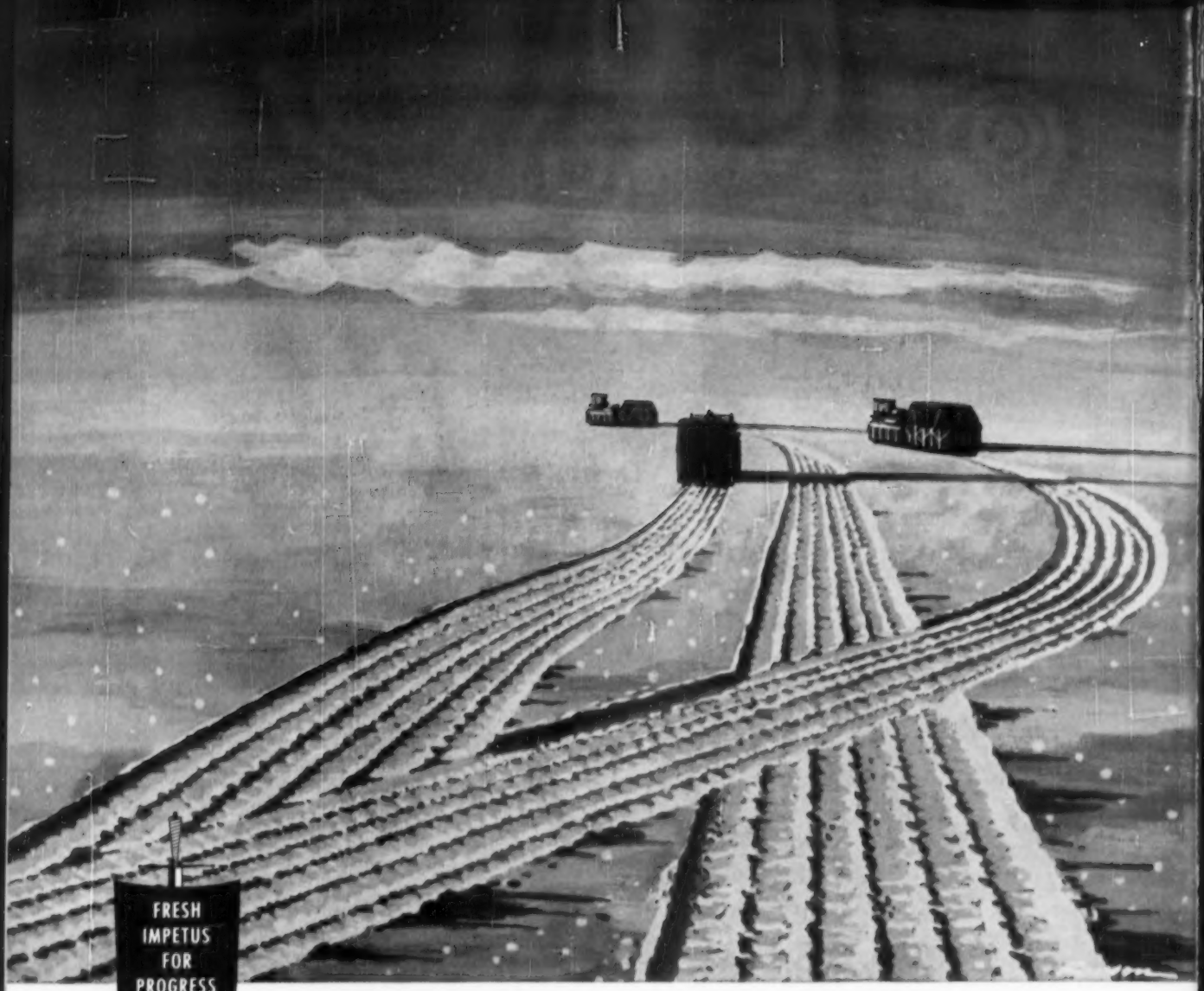

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AMB Plans Full Operation by November

Three-member board will have staff of 60 to aid research program to untangle traffic bottleneck.

By L. L. Doty

Washington—Newly authorized Airways Modernization Board is expected to become a "going concern" within 60 days to launch the long-range, full-scale research and development program designed to untangle the nation's air traffic bottlenecks.

A White House spokesman admits the time estimate is "on the optimistic side" but adds that, barring any unforeseen difficulties, the program proposed by former presidential aide Edward Curtis (AW May 20, p. 26) should be in full operation no later than November.

Staffing of the three-member Board is planned to begin immediately after job descriptions and functions have been written by a Civil Service Commission expert on personnel assignment.

AMB Organization

Initially, the Board will consist of a staff of approximately 60 people with five members drawing $19,000 annually and 20 members being classified in the "super grade" category which calls for between $13,000 and $15,000 yearly.

The Board will be administered by a three-member group consisting of the chairman and the secretaries of defense and commerce. A meeting of the three will be held shortly at which time it is expected that the secretaries will name delegates at the assistant secretary level to represent them on the Board.

Organizational pattern of the interim board is being outlined by a group of 25 technicians representing the military services, Civil Aeronautics Administration and civil aviation. Assigned to the AMB on a temporary basis for a period of 30 to 90 days, the special consultants are working in task force groups to lay out an operational structure for the Board during the next year.

The Airways Modernization Board became a fact earlier this month when President Eisenhower signed the bill that gave the Board legal status as an independent agency (AW Aug. 19, p. 25). Later, the Senate unanimously confirmed the nomination of former USAF Lt. Gen. Elwood Quesada as chairman of the Board. Quesada will serve in the dual role of Board chairman and as special assistant to the president for aviation facilities.

The Board was proposed by Edward Curtis in his final recommendations to the President as an interim means of immediately tackling the nation's serious air traffic control problems.

Although it is now an independent agency, the AMB will be absorbed by the permanent independent Federal Aviation Agency when it is established sometime within the next three years. In passing the Airways Modernization Bill, Congress called for a report with recommendations on the establishment of the Federal Aviation Agency by January, 1959 (AW Aug. 5, p. 25).

End to ANDB

The Airways Modernization Board spells the end of the Air Navigation Development Board which was originally organized in 1949 and reorganized in 1954 to handle research and development of air traffic control facilities. ANDB will be completely absorbed by the AMB and it is expected that most of the ANDB staff will be transferred to the new Board.

ANDB staff currently consists of five full time members. An additional 20 persons are assigned to the ANDB in an active capacity. Two groups, a system engineering advisory team and an operational advisory team, complete the organizational structure of the ANDB. Each of the teams is made up of one representative from the Army, Air Force, Navy and Commerce Departments.

AMB will take over all ANDB facilities and will move into the old Board's quarters at 916 G Street, Northwest.

Quesada's Task

ANDB funds, amounting to about $4 or $5 million, will be used to launch the AMB program. Additional funds will be transferred from Commerce and Defense to cover expenses during the balance of Fiscal 1958 although a House of Representatives amendment to the Airways Modernization Bill that limits the President's authority to transfer funds from other agencies to the Board, could require a special appropriation. AMB will have its own budget in fiscal year 1959.

In his dual role as chairman of the AMB and special assistant to the President on aviation matters, Quesada will be charged with the responsibility of running the Board and laying the groundwork for the permanent Federal Aviation Agency.

He expects to utilize a staff of about six people in preparing his proposals and recommendations for the organization and operation of the permanent agency. Target date Quesada has set for the project is January, 1959.

As presidential aide, Quesada will

Lufthansa 1649A Deliveries to Begin

Lockheed 1649A deliveries to Lufthansa German Airlines are scheduled to begin in October. Carrier will receive four of the planes with last delivery set for January, 1958. They will be used on North Atlantic run in nonstop service.

serve as non-voting chairman of the Air Coordinating Committee which eventually will be absorbed by the FAA, act as advisor to the President on aviation matters and "provide leadership" in the establishment of the Federal Aviation Agency.

The entire program has received the strong support of civil and military aviation segments and the Civil Aeronautics Administration. However, Civil Aeronautics Board chairman James Durfee indicated during congressional hearings on the Airways Modernization Bill that he would be unwilling to surrender any of CAB's functions to FAA.

Under the Curtis proposals, the CAB would retain economic regulatory control of the airlines and airline route allocations but would relinquish all aviation safety functions.

J. Gordon Bennett, who was associated with the William Barclay Harding group that found the need for an improved airways system (AW Jan. 16, p. 26) and the Curtis group throughout the entire program, will phase out of the AMB picture as the organization takes shape and serve as executive assistant to Quesada in his capacity as special assistant to the President. Bennett, a former airline and Navy pilot, was earlier associated with the CAA and later was assigned to the Commerce Department as aviation advisor to the undersecretary.

Airlines Edge Into Mass Market, Survey Shows; "Pay Later" Lags

By Glenn Garrison

New York—Transatlantic scheduled airlines have begun to penetrate the potential mass market of average-income passengers, a Port of New York Authority survey indicates.

But transatlantic air travel still is largely for the well-heeled, the survey also shows. It covers the April/October 1956 on-season and includes questionnaires completed by 15,000 passengers on 450 flights from New York to Europe, Bermuda and Latin America.

Pay Later Apathy

The strongly pushed pay-later plan to attract vacationers had scarcely made a ripple in the transatlantic ticket sales, the survey shows.

Other highlights:

- **Fewer than** a third of the American transatlantic (to Europe) passengers were traveling for tourist purpose, despite the on-season period covered. Most of those visiting Bermuda were tourists.
- **Great majority** of American transatlantic travelers stay more than two weeks abroad during their trips. The 15-day excursion fare introduced last fall therefore would seem to be vulnerable to critics who contended the time was too short (AW Feb. 18, p. 39). On the other hand, it may be creating a new market.
- **About** 85% of American tourists leaving New York to visit the region which includes Central and South America, the Caribbean and Bermuda were going only to Bermuda. The air tourist market to other Latin American points would seem to be virtually untapped as far as departures from New York are concerned (Puerto Rico and Mexico are excluded from the survey).
- **Travel agent** provides both overseas and domestic carriers with a tremendous volume of first-time customers. His influence lessens somewhat on succeeding trips, but only the many-time riders bypass him in significant numbers.
- **Transatlantic passengers** traveling for tourist reasons on tourist-fare flights are outnumbered by those traveling for other pleasure purposes, such as visiting relatives abroad.

$20,000 Level

That overseas air travel is not yet everyman's pleasure is indicated by the survey finding that about 25% of all the American passengers had family incomes of $20,000 or more, a level enjoyed by 1% of the United States population. More than a third of the Americans traveling for tourism purposes were in this high-income group.

About 20% of the Americans traveling for tourist purposes, however, reported family incomes of less than $6,000. Seventeen percent of these tourists belonged to the $3,000-$6,000 family income group, representing 40% of the population. Nineteen percent were in the $6,000-$10,000 bracket, making up 23% of the population.

An International Air Transport Assn. report on the first five years of transatlantic tourist fare service issued last spring cited figures which indicated a somewhat higher penetration of the mass market.

Age Groups

The report put 34% of all transatlantic passengers in the $5,000 or less income bracket, and said 51% of the passengers had incomes of $7,000 or less. The figures were based on a survey by one airline.

IATA said it would not want to dispute the Port Authority figures, which are based on a more intensive survey. The important thing, according to an IATA spokesman, is the fact that the carriers have begun to break the crust of the mass market.

The Port Authority survey figures concerning age of passengers bears out the IATA report's contention that tourist class passengers are younger than first class passengers. The IATA report calls this "perhaps the most significant figure in all this maze of statistics," concluding that tourist class services have opened up travel to younger people.

Tourist Percentage

Only 31% of the American transatlantic passengers surveyed by the Port Authority were going overseas for touring. Of all American transatlantic tourist fare passengers, 35% were tourists in the sense that tourism was the purpose of their trip. Of first class American transatlantic passengers, 24% were tourists.

"Other pleasure" purposes sold more tourist fare tickets to Europe than did tourism, the Port Authority found. Forty-one percent of tourist class ticket holders were in this category, and 12% were in the "personal affairs" class of trip purpose. By comparison, 16% of the first class passengers were on "other pleasure" missions and 8% were "personal affairs" travelers.

Transatlantic tourist fare service, it would seem from the above, is presently depending less on the vacationer making a free choice of how to spend his time and money than on the traveler who may have saved up for years to visit a relative in the old country, or who has some other already existing reasons for flying to Europe.

Business travelers made up 12% of the American transatlantic tourist class travelers, 52% of the first class passengers.

Foreign Tourists

Among foreign residents, who comprised about a fourth of the total transatlantic passengers, only 10% of the tourist class riders were tourists. Forty percent were traveling for "other pleasure," and the percentage of visitors to relatives abroad was heavy (22%) as might be expected.

On the Bermuda-Latin America flights, most tourist fare passengers—80%—were tourists in fact.

The touted "Fly Now, Pay Later" plan made a poor showing in the Port Authority survey. Only 2% of American tourists reported use of the plan to finance their trips. Of travelers for all purposes, 4% used pay later on transatlantic flights and 2% on Bermuda-Latin America trips. Foreign residents made slightly greater use of the plan: 7% transatlantic, 6% Bermuda-Latin America.

Most American transatlantic passengers who used pay-later (26%) were in

Idlewild "Terminal City" Progresses

International Arrival Building and its adjacent wing buildings for foreign-flag airline offices at New York International Airport are under construction at right, above. Ramp runs from lagoon through base of control tower to building. Opening date, postponed from July 31, has not been fixed by Port of New York Authority.

the $6,000-$9,000 income group. Surprisingly, 13% of the transatlantic pay-later passengers reported family incomes over $20,000. On the transatlantic route, 7% of the personal affairs travelers used credit, 5% of the visitors to relatives and 3% of the business passengers.

Survey Questions

The surveyed passengers were asked for information concerning the frequency of their air trips, both domestic and overseas, and where they usually bought their tickets.

Travel agent services, the replies indicate, are used in a slowly decreasing ratio by American passengers as their number of trips increases. According to the survey, the agent sells 69% of first-trip tickets to Americans making their first or second flight.

From the third to ninth such trip, the percentage is almost the same—68%; by the tenth to 24th trip, the percentage is 52%; by 25 trips and over, the agent accounts for 47% of sales.

About half of the transatlantic passengers surveyed were on their first or second trip; 34% three to nine trips; 10% ten to 24 trips; and 5% 25 or more trips.

About two-thirds of the American transatlantic travelers spend more than four weeks abroad, the survey found, and 90% of them stay more than two weeks.

Average is about six weeks. Duration of trip in Bermuda and Latin America is shorter by one or two weeks for about three-fourths of the American travelers.

Among Americans traveling to transatlantic destinations for tourist purposes, the biggest group—18%—remain four weeks.

Only 7% of the tourists remain only two weeks or less.

Importance of New York

Importance of New York to the transatlantic business was pointed up in the survey, which found that 80% of U.S. passengers on the route depart from here.

Approximately half of the Americans flying transatlantic from New York listed Paris as one of their destinations. London was listed by 40% and Rome by 30%.

The Port Authority survey also covered five off-season months, which will be analyzed in a supplemental report by the agency.

United's Custom Coach Plan Approved by CAB

Washington—Approval of a United Air Lines proposal to inaugurate custom coach service at fares slightly higher than regular coach service fares has been recommended by Civil Aeronautics Board Examiner Ferdinand D. Moran.

The airline proposed the service in DC-7 aircraft with six rows of three-abreast seats and a total capacity of 86 passengers.

Full course hot meals will be served at no extra charge and passengers will be permitted to reserve seats on these flights.

Cruising at 340 mph., the DC-7 is able to fly from San Francisco to New York in eight hours.

United has filed a tariff providing for a one-way fare of $102, $3 higher than that for the present regular coach flight fares.

Fares from Chicago to Los Angeles, San Francisco or New York, or between Los Angeles and New York range from $1 to $3 higher than present coach fares on these routes.

Equipment, Routes Cripple Local Lines

By Ford Eastman

Washington—Lack of modern flight equipment, strong route structures and present rate-of-return methods are cited by local service airlines as main stumbling blocks to subsidy-free operations.

These are problems which face the industry as a whole. On an individual basis, there are others.

A typical example is Trans-Texas Airways, which operates 4,704 unduplicated route-miles in Texas, Arkansas, Louisiana and Tennessee. R. E. McKaughan, Trans-Texas president, has analyzed his company's problems from the standpoint of his treasury, traffic and operations departments.

One of the most acute problems, according to the airline's treasury department, is the rate-making policies of the Civil Aeronautics Board. The department claims that the policies have prohibited the local service industry from experiencing any record of profits and that the criteria used by the Board in rate cases is unrealistic.

The rate of return to carriers is now determined on a rate base equal to the original cost less book depreciation of the used and useful assets. This matter is currently under consideration by the CAB in the Rate of Return to Local Carriers Case. Local carriers generally want rate of return determined in revenues rather than investment.

In addition to the rate making policies, Trans-Texas says the CAB could render a great service to the local service industry by handling applications for mail rates on an expedited basis. President McKaughan says:

Waiting Period

"There appears to be no reason why following an application for a new rate that the new rate could not be finalized within a 90-day period as contrasted to the present minimum time of one year, which in some instances has stretched out to four years for some carriers.

"Obviously," he added, "this type of procedure places many unnecessary burdens upon the carrier and makes planning extremely difficult, if not completely impossible. We know of no other industry that is subjected to these stifling conditions while still being expected to be extremely efficient and economical."

Local carriers, like domestic trunklines, are plagued by rising operating costs. McKaughan points out that increased labor costs alone comprised approximately 80% of Trans-Texas' total increased costs and have contributed substantially to increased subsidy, since passenger fares are regulated and cannot be raised to offset these higher costs.

"In addition to labor," he said, "costs in the form of landing fees and office rentals at the various airports we serve have steadily increased. Local service carriers are often the victim of being required to pay trunkline landing fees, while carrying only a small percentage of traffic."

As for route structure, the airline said the CAB should lift restrictions which require local carriers to make multiple stops between terminals. The airline advocates either nonstop or one-stop between terminals as well as points served exclusively.

Trans-Texas Airways also would like to have the CAB adopt a more liberal policy toward permitting local carriers to suspend unprofitable points. At the same time it said trunklines should be suspended from points and routes which are obviously of a local nature and the local carriers substituted.

Airport Problem

The airline's operations department summarized the carriers most pressing needs in four categories—airports, equipment, navigation aids and administration.

"The airport problem is fast becoming a major one for the local service carrier," the airline said. "Cities are building larger and more elaborate facilities every day. With the advent of jet aircraft and their need for longer and stronger runways, revamped loading areas, and special fueling facilities, the major cities are going into another round of expansion. At least part of this expansion will be borne by local carriers in spite of the fact that the impetus for the expansion is long range markets which the local service carriers cannot serve."

Trans-Texas says that in the smaller cities, and in some cases major cities, duplication of facilities has become a serious handicap to local carriers. Communities located close together appear to be reluctant to enter joint airport projects that would serve two or more communities. The airline said that, in one instance, where two cities were only 20 miles apart, each built its own airport, one 12 miles to the south, the other 12 miles to the north.

McKaughan said the airline's present DC-3 equipment was not designed to do the job local service carriers have to do.

"Our equipment should be substantially faster from block to block," he said, "capable of taking off very short, easy to load and unload, and it should have the same sort of expandable capacity which is found in city buses. This last is a concept long recognized by short haul surface operators who have peak segments and peak hours. Their equipment is designed to provide for peak loads up to 150% increase in capacity with the same equipment.

"Perhaps this same concept could be used to advantage in our industry by using combination freight-passenger aircraft which could be momentarily converted to all passenger configuration," he added. "All of this is based on the possibility that manufacturers will actually look at our operation, study our needs and give us a piece of equipment that meets these needs—not a compromise which only scratches the surface."

Navigation Aids

The airline said the navigation aid problem is one that has plagued the local service industry since its inception. If a navigation facility does not exist at a point the carrier serves, the line must either put one in at his own expense or offer only limited service.

Airways, controlled airspace, control towers and other similar aids do not exist in many cases, McKaughan claims. Improvements to the airways system have been based on the long haul service which has many more routes and altitudes to choose from, while the local carrier must run a gauntlet of uncontrolled private and military aircraft. He said that federal authorities apparently do not recognize this hazard because they do not control the area and, thus, they have no statistics for justification.

Another problem of the operations department, the airline said, is the high cost of administration in a regulated industry. "The multitude of regulations, reports, and procedures which must be compiled," the department said, "point up this problem as one major area for technological improvement."

In addition to suggestions by other departments on ways for local carriers to become self-sufficient, the Trans-Texas traffic staff recommends a reduction in stations, ground operations and traffic expenses through more efficient utilization of ground personnel and facilities.

Ground costs are, according to the traffic department, about equal to flight costs on U.S. domestic airlines. In actual practice with short-haul carriers, the costs usually are greater than half of the airlines' revenue plane mile cost.

The department said ground costs, and consequently break-even needs, can be reduced through greater flight fre-

quency at existing stations. With a greater frequency of flights at existing stations, an airline can handle more passengers and pounds of cargo per employe, ticket counter, utility expense unit and square foot of rented space.

Bonanza Air Lines of Las Vegas, Nev., points to route strengthening and acquisition of new modern equipment as the two main steps on the road to subsidy-free operations.

Edmund Converse, Bonanza president, says that, with the coming of jet and turboprop equipment, the trunk airlines will have more opportunity and desire to be suspended at their marginal and intermediate stops. Local carriers can be strengthened by adding many of these cities to their systems.

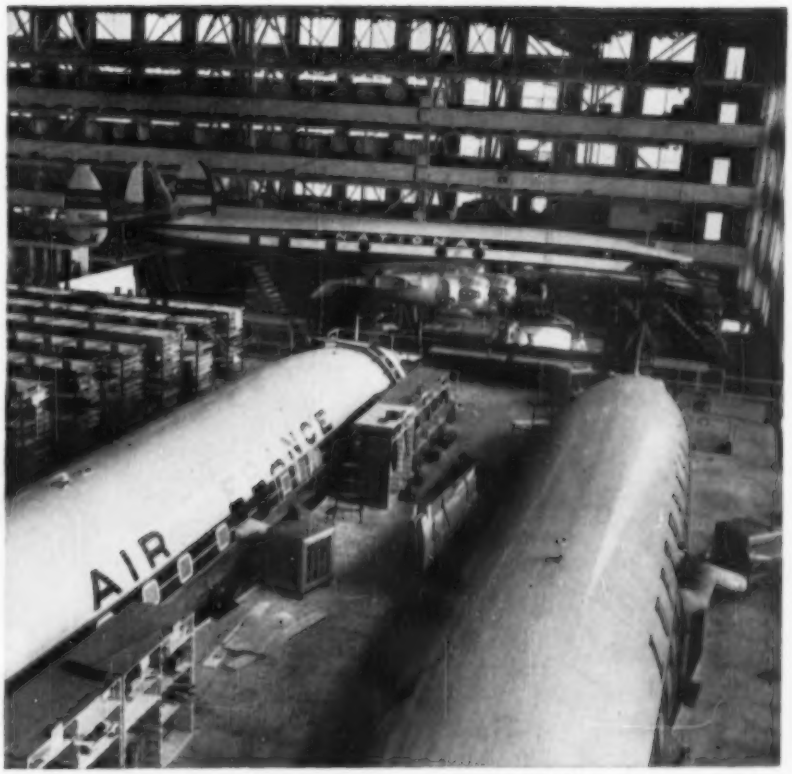
Converse said trunklines are now reluctant to give up intermediate points that are good traffic producers from a local service point of view, but which the trunks might find unprofitable in the coming jet age. However, he said, the locals could be strengthened immeasureably by adding these communities to their systems.

Present routes, he adds, can be strengthened by the issuance of skip-stop authority for all flights in excess of two round trips daily to intermediate points. He believes the lifting of such restrictions would not harm trunklines but would improve service to those that require it.

Bonanza, which has ordered Fairchild F-27 turboprop transports to replace the DC-3, is leaning heavily on passage of the Guaranteed Loan Bill in Congress in order to obtain the necessary financing to purchase the planes.

A somewhat similar situation was outlined by North Central Airlines of Minneapolis, Minn. Hal N. Carr, president, said his company, as well as the industry, is in dire need of new aircraft that will carry a greater payload at less cost per seat-mile and at the same time enable the airline to offer the faster, more comfortable, more saleable merchandise. Thus far, Carr added, aircraft manufacturers have been reluctant to develop a suitable DC-3 replacement for the local industry, largely because of its unattractive earnings record.

"Improvements in route structure would also materially strengthen the local airlines," Carr said. "Longer-haul authority on selected routes would be extremely beneficial to help offset the great losses incurred at the weaker points. However," he added, "this is not to suggest that we would like in any way to depart from the local service type of operation. Quite the contrary, we are now and certainly will continue to increase service steadily to our present smaller cities and add more small stops."



Constellations for Three Airlines

Two Lockheed 1649A fuselages, planes ordered by air France and Lufthansa, are berthed in manufacturer's Burbank plant. In background is 1049H nearing completion for delivery to National Airlines for New York-Miami service.

Realistic Schedules Ordered by CAB

Washington—Civil Aeronautics Board last week ordered domestic airlines to complete at least 75% of their flights within the elapsed time shown in their schedules.

At the same time, the CAB deferred action on the proposed on-time departure and arrival rule until after an evaluation of the elapsed time regulation.

The Board's action resulted from an Air Line Pilots Assn. protest that airlines publish schedules for flights that are "unrealistic" and cannot be completed on time. The Board originally proposed to require each airline engaged in passenger operations to complete at least 75% of scheduled flights on time in the absence of intervening factors beyond the carrier's control. If this was not done, the Board would have required the airline to revise its schedule realistically.

The new regulation differs in that 75% of all flights must be completed within 15 minutes of the block-to-block time shown in the schedules on the basis of three calendar months instead of one. Also, on-time departure and arrival performance is not part of this regulation. The CAB said the new regulations do not apply to helicopter operations or to all-cargo flights.

Carriers will make monthly reports of flight delays to the CAB. The reports will be analyzed for flight-time reliability and for determining whether the Board should adopt an on-time performance regulation.

In explaining the regulation, CAB said flight delays, which experience shows will be incurred, are to be considered by air carriers in scheduling flights. However, those delays caused by conditions beyond the carriers' control and which could not have been anticipated by the exercise of reasonable prudence may be shown by way of justification.

Accordingly, the CAB added, an airline should be able to plan its operations to insure that 75% of the in-flight delays that it will experience will result in no more than 15 minutes in elapsed time without inconvenience to the public or undue burden to itself.

For example, in-flight delays affected by the weather, air traffic control problems and airport congestion would be excusable, if unpredictable, as would any in-flight mechanical difficulty that affects speed.

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Mach 2 Transport Urged for British

London—Development of a 1,700 mph. 68-engine jet transport and nuclear powered super-cargo aircraft has been urged on the British aircraft industry by a special committee set up to study the problems of Britain's air transport policy.

The group was established by the Air League of the British Empire with Sir Miles Thomas, former head of British Overseas Airways Corp., as its chairman. It had no official status.

Sir Miles said technical advice received from the aircraft industry indicated that Britain could capture the "blue riband" North Atlantic route within the next 12 years with a supersonic airliner capable of flying from London to New York in 2½ hours. The 135-passenger aircraft would cruise at 60,000 ft. It would land and take off vertically.

68 Engines

A display model of the proposed airliner revealed 56 engines in the main fuselage for vertical power and 12 engines mounted as vertical tail fins, six on each side, for cruising.

Fuel tanks were mounted aft and passenger seating in a tube in the center of the fuselage of the dart-shaped model. Sir Miles said the proposal had been evaluated technically by Rolls-Royce as a feasible project.

The committee's report said there is a growing need for a very large cargo transport operating at economic speeds on the order of 500 mph. and at altitudes of not less than 25,000 ft. and over ranges of 3-4,000 miles.

It could now be designed on conventional engineering lines to operate at 50-60% of current cargo rates, the report said, while a bolder venture would be long-term development of a nuclear powered cargo carrier which would weigh several hundred tons.

"Its cargo capacity might well be enormous compared with that of the more conventional aircraft, and its successful construction might well place this country in the lead in the mercantile transport of the future," the group suggested.

Predicting that world air traffic will quadruple during the next ten years, the committee said a proportion of the expected increase in traffic should be allocated to Britain's independent airlines.

It said BOAC and British European Airways, the state owned airlines, had done a good job in a difficult period but should not "be saddled with entire responsibility for the tremendous increase in traffic expected over the next ten years." The committee's report suggested that if they were, they might become so large as to lose their efficiency.

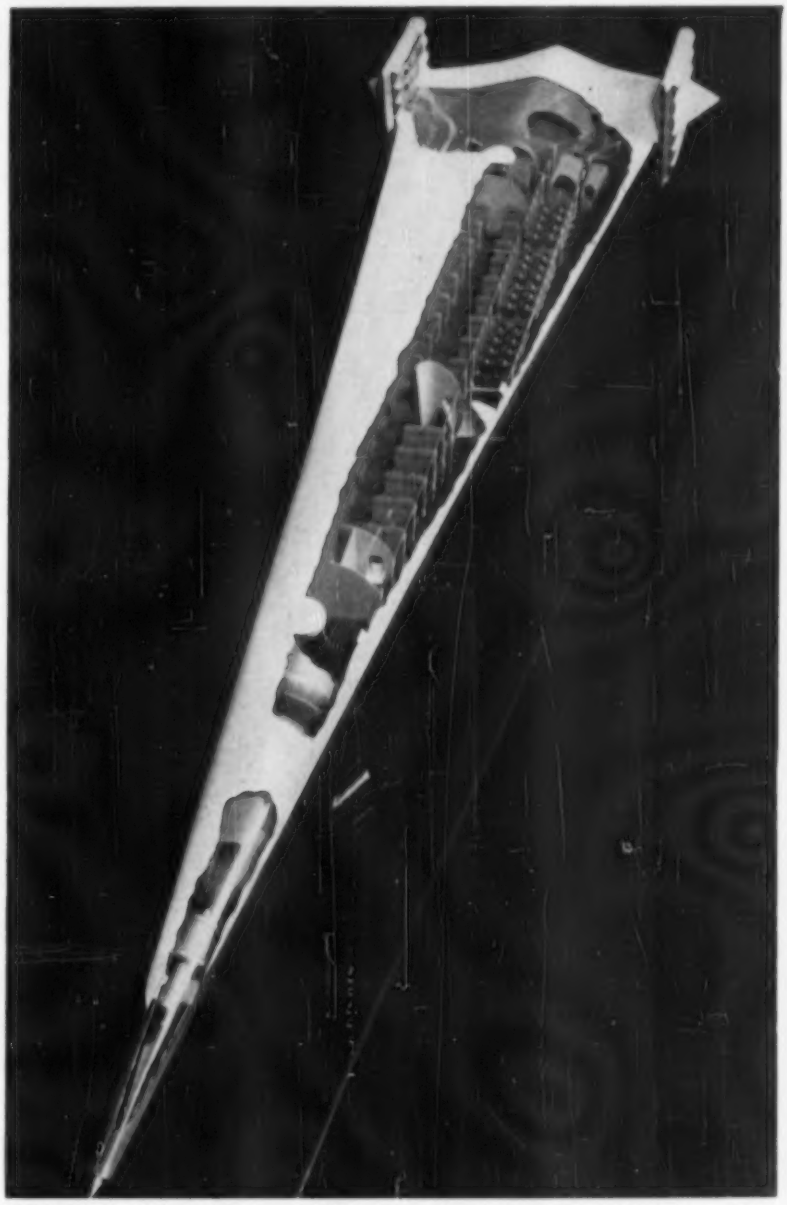
Another reason was given by Sir Miles Thomas when he told a press conference, "I don't agree with this monopolistic attitude that has been a feature of the postwar British airline scene." Sir Miles resigned from BOAC last year.

Cites 707

The committee also suggested that Britain set up a proving unit—"somewhat on the lines of the USAF proving command" to test new transport aircraft. It argued that military backing is responsible for the success of American transports.

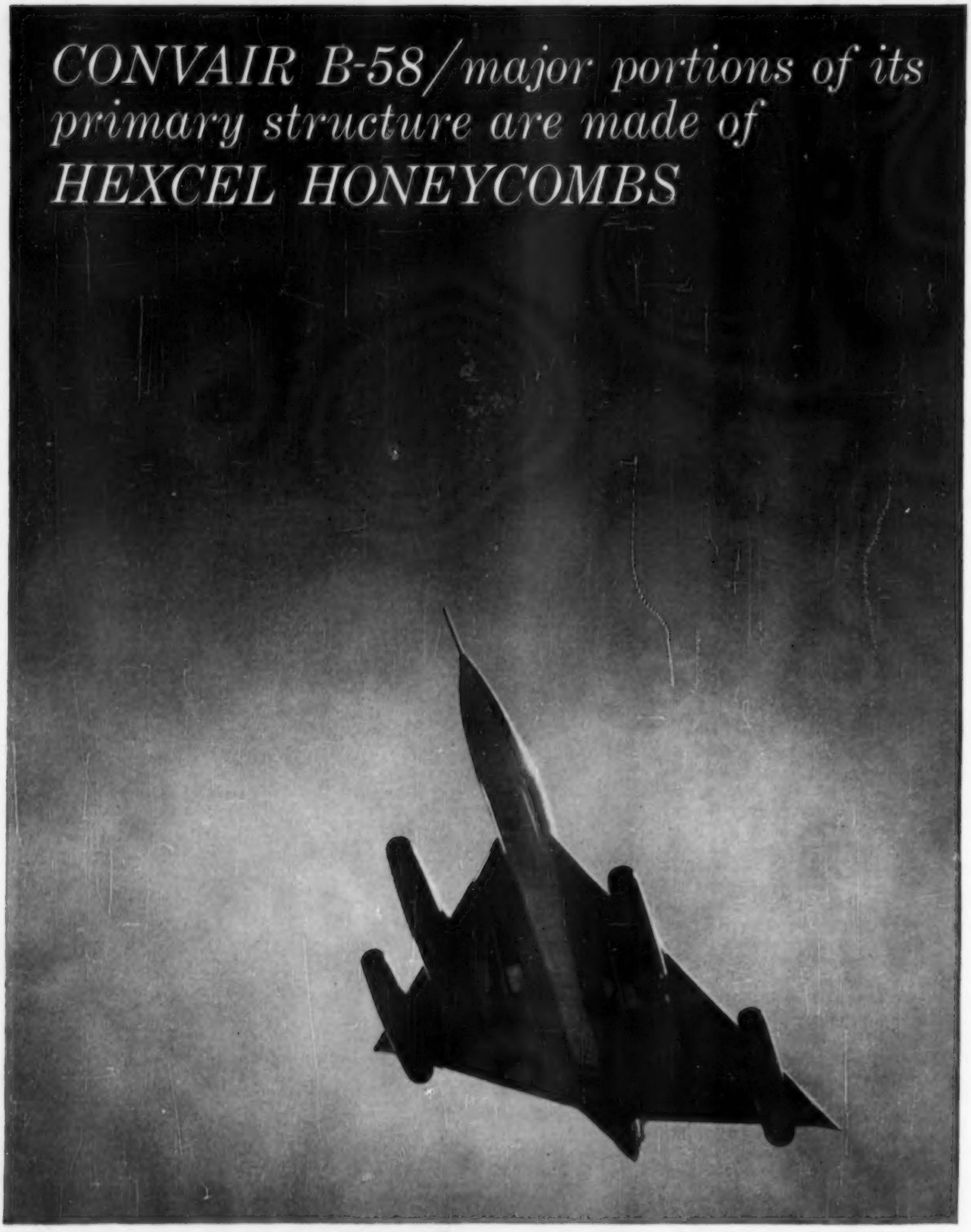
"An example is the Boeing 707 jet airliner, which is expected to come into operation on the world's air routes in 1960 or 1961," the committee said. "This aircraft has been evolved from the USAF's KC-135 jet tanker which had achieved many hundreds of hours of development flying before the civil prototype took the air."

There was no mention of the fact



ARTIST'S conception of supersonic jet transport based on advice received from British aircraft industry. Aim is to make Britain leader in world air transport.

CONVAIR B-58/major portions of its primary structure are made of HEXCEL HONEYCOMBS



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that Boeing built the 707 prototype with its own money before receiving any order for it.

Many British observers were disappointed at what they regarded as the lightweight and unrealistic nature of the report. But the committee said:

"We feel most strongly that this country must be imaginative and reach out into the future by proceeding to develop a supersonic airliner capable of vertical takeoff and landing and of crossing the Atlantic in between two and three hours. We are satisfied from expert evidence given to us that this is a practical proposition within the next twelve years and it is for us an economic necessity as well as a matter of prestige."

The committee said Britain with such an aircraft would regain the blue riband of the North Atlantic, increase enormously its aircraft export market and under the new defense policy be in a position to marshal its military forces anywhere.

Conceding that the project would be beyond the technical and financial resources of any one firm, the report expressed the belief that if the leading firms combined in syndicate form under inspired leadership, city bankers might come to their aid financially in the manufacture of the aircraft.

French Use Flybys To Promote 1649As

Paris—Air France is introducing its new Lockheed 1649A Super Starliner Constellations to the French public with an advertising stunt beamed at millions of vacationing Frenchmen.

Under the Air France plan, a Super Starliner is flown non-stop 2,500 mi. from one end of the French coastline to the other. The flight is made at an altitude of 1,000 ft. Several days beforehand the company advertises in hundreds of newspapers, giving the date of the flight, the complete list of the hundreds of beaches the aircraft will pass over, along with the exact time it will fly by.

The ads promise vacationers that, "you can set your watch by a Super Starliner." Configuration characteristics are given for easy spotting, and readers are told that "the black nose you see holds the weather radar."

The flight begins at Abbeville, on the Flemish coast, at 0956 hours and ends with a landing at Nice at 1905. So far, the company claims, it has hit the rigid scheduling on the nose.

The advertising gimmick actually was first tried by Air France in 1955, when the company was introducing its Super Gs. It was such a success with the public that Air France officials decided to do the same thing with its 1649As.

AIRLINE OBSERVER

► Civil Aeronautics Administration expects to commission ILS facility at Washington National Airport with ground antenna buried in the runway by December, 1958. Flush antenna will eliminate the 150-ft. offset in instrument approaches and permit landings under conditions approximating zero-zero. Elfaka-type runway lights (AW April 15, p. 99) that eliminate the "black pit" illusion in landings also will be installed. Meanwhile, airlines and Port of New York Authority have tentatively agreed on flush-type centerline runway lighting for the planned parallel instrument runway at New York International Airport following a recent meeting in Washington in which the CAA reported on tests of the lights at Andrews Air Force Base.

► Rolls-Royce has ordered a Vickers Viscount for use as a flying testbed. Aircraft is nearing completion.

► Pan American World Airways last week applied to the Civil Aeronautics Board for permanent authorization to operate service between Seattle, Portland, Hawaii. The airline currently holds a temporary certificate to operate between the Pacific Northwest and Hawaii and a permanent certificate to operate between Los Angeles and San Francisco and Hawaii. Northwest Airlines, which operates between Seattle, Portland and Hawaii also under temporary authorization, has not yet filed application for a permanent certificate on the route.

► Transocean Air Lines has been awarded a $2.5 million domestic cargo contract by the Navy to operate scheduled flights five days a week during Fiscal 1958 over a 7,500 mile route linking naval centers between the terminal points of Alameda, Calif., and Boston. The supplemental carrier expects to log more than two million miles of flying and more than 20 million ton-miles during the year under the contract.

► Rolls-Royce engines are specified by both de Havilland and Bristol Aircraft in their short-medium range jet transport designs for British European Airways (AW Aug. 5, p. 47). Bristol 200 also is offered with Olympus 553 engines although BEA favors Rolls-Royce powerplants due to the favorable experience with Dart powered Viscounts. Rolls-Royce engines involved are the RB-141 Conway at 12,000 lb. thrust and RB-140 with 8,000 lb. thrust Bristol and de Havilland are each proposing three and four engine models for BEA consideration. Decision, originally due July 20 (AW May 27, p. 41), should be announced soon.

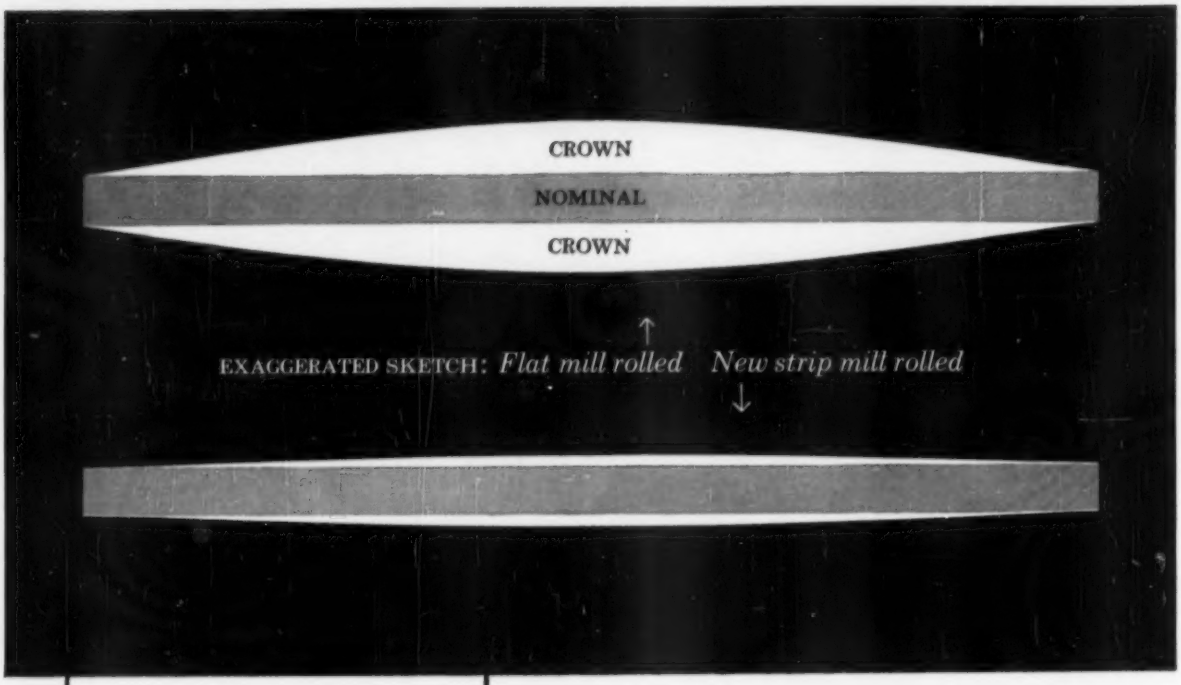
► Northwest Airlines President Donald Nyrop has re-emphasized the airline's intention to purchase turbine-powered aircraft "to make certain that our company will be fully competitive in the jet age." Nyrop says the company is exercising "sober caution" in its evaluation of aircraft that will be available and adds that "a great deal of time and attention is being devoted to negotiating final arrangements. . . ." Northwest Airlines is the only U.S. trunk carrier that has not placed an order for new turboprop or turbojet aircraft.

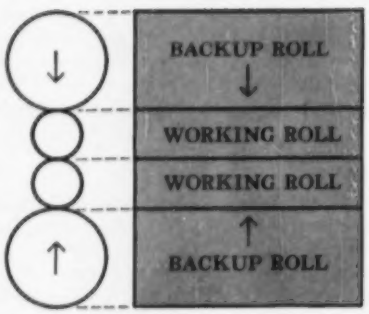
► Air traffic control radar beacon system will soon undergo in-service evaluation tests. Approximately 200 air carrier transport aircraft and an undetermined number of civil aircraft are being equipped with transponders as part of the evaluation program.

► Flying Tiger Line is attributing sharp increase in gross revenues to its new fleet of 12 Lockheed 1049H Constellations placed into service in May. Revenues earned in May and June amounted to more than $6 million, or approximately $2 million over the carrier's average last year. The airline also reported that the Constellations enabled it to report the first monthly operating profit since last September. Operating profit for May and June this year totaled $300,000.

► Rolls-Royce Dart turboprop engines operated in North America have passed the million hour mark. Trans-Canada and Capital Airlines Viscounts account for the heaviest utilization of the engines.

Weight slashed on wide sheet





Modern 4-high strip mill equipment for wide sheets provides backup strength to the working rolls. Wide sheet was previously made on old-fashioned flat mills (2 rolls high) and the rolls deflected in the center, resulting in excessive crown and weight.

New Alcoa rolling equipment recently installed means a lot to the aviation industry. The new facilities virtually eliminate "crown or centers" in wide sheet. Weight and cost per sheet are greatly reduced. The same thickness precision previously available in widths up to 60 inches is now obtainable in wide sheet.

For example, a sheet of .060-inch material, 84 inches wide and 24 feet long, when rolled on a flat mill, has a typical crown of .008 which adds 13 pounds excess weight. When rolled on the new 4-high strip mill, typical crown is reduced to .0015, leaving only 2.44 pounds excess weight. Weight saved per sheet, 10.56 pounds or a reduction of 6.6 per cent. Dollar savings are proportionately substantial.

With these new facilities, Alcoa can effectively minimize crown in sheet 60 to 84 inches wide in thicknesses up to .125 inch nominal. For more information and specifics on the weight and cost saving on your requirements, see your Alcoa sales engineer or write ALUMINUM COMPANY OF AMERICA, 1800-H Alcoa Building, Pittsburgh 19, Pa.

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SHORTLINES

▶ **Trans World Airlines** will begin overnight service between California and Europe on Sept. 29 using the Lockheed 1649 Constellation on the newly awarded polar route. The 1649 will be used on the San Francisco-Paris-Rome flight as well as the Los Angeles-London schedule. The 1649 also will be flown on a new nonstop New York-Rome route beginning Oct. 2.

▶ **Flying Tiger Line** will begin through-plane, all-cargo service between New England and major Midwestern and West Coast cities in October using newly-delivered Lockheed Super-H Constellations. The service will run from Boston and Hartford, Conn., to Chicago, Los Angeles, San Francisco and the Pacific Northwest.

▶ **Southern Airways** will inaugurate regular daily service to Eglin Air Force Base, Fla., on Sept. 3. Two roundtrip flights a day to Atlanta, one via Dothan, Ala., and the other via Columbus, Ga., will offer both military personnel and civilians their first direct air service to the Georgia capital.

▶ **National Airlines** reports a net income of $3,133,499 for the 12-month period ending on June 30. Total operating revenue was $56,823,471; total operating expenses, $50,815,430.

▶ **Bonanza Air Lines** flew 2,818,602 passenger-miles in July for an all-time company record. The airline carried 13,295 passengers during the month, a 1,262 increase over the previous month. Bonanza expects to start new nonstop and multi-stop routes in Salt Lake City from Phoenix soon if the move is approved by CAB.

▶ **Lufthansa, German Airlines** will offer a 16-day tour to Europe from Chicago beginning Sept. 15. Features of the tour include a fashion show in Rome, visit to a Geneva cosmetic factory, tour of a Paris perfume plant and visit to a London cooking school. Fare is $845.70

▶ **Vickers** latest version of the Viscount 800 series has made its first flight equipped with four Rolls-Royce Dart R.Da.7, Mark 525 turboprop engines. In its final form, this series will be known as the 810/840, the 810 being fitted with the R.Da.7 engines and the 840 with the R.Da.11 turboprop engines.

▶ **North Central Airlines** carried a new one-day company record of 2,626 passengers on Aug. 16. Line has carried over 400,000 passengers this year.

Zero-Zero Landings—IV

The experimental flying at Andrews Air Force Base described in previous columns yielded enough data to fill several volumes. I personally feel that these flights were of tremendous value and that we need more. Here's why.

As in previous years 1957 has seen a continual struggle by many airlines to stay in the black—there are even applications for a rise in fares for this purpose. Indeed solvency is the great concern of all branches of aviation. And unless an airplane moves, and moves safely and efficiently from point to point, aviation travel is meaningless for there is nothing else to sell. On the airlines this means schedule reliability. Reliability means on time departures and arrivals—arrivals at destinations, not alternates.

Second Fiddle?

Occasionally one gets the impression that some airlines have allowed operational matters to be relegated to a second fiddle position behind a sales push. Selling is obviously important and I would not attempt to belittle it. But first you must have a product to sell.

At best airline profits represent a small fraction of total investment. Delays, diversions and cancellations can easily wipe out the "gravy." Wouldn't bookkeeping be infinitely more rosy if everything went on schedule? As with any other part of modern business the operational end requires research and thought and work—and money too. It means devoting men and equipment as my airline did on the Andrews project.

Sure this is expensive. And aids such as the flush lighting which we are recommending are expensive—in the millions. Yet installation costs are a drop in the bucket compared to the money that will be invested in our new jets and the profit they would make if they could operate on schedule all the time.

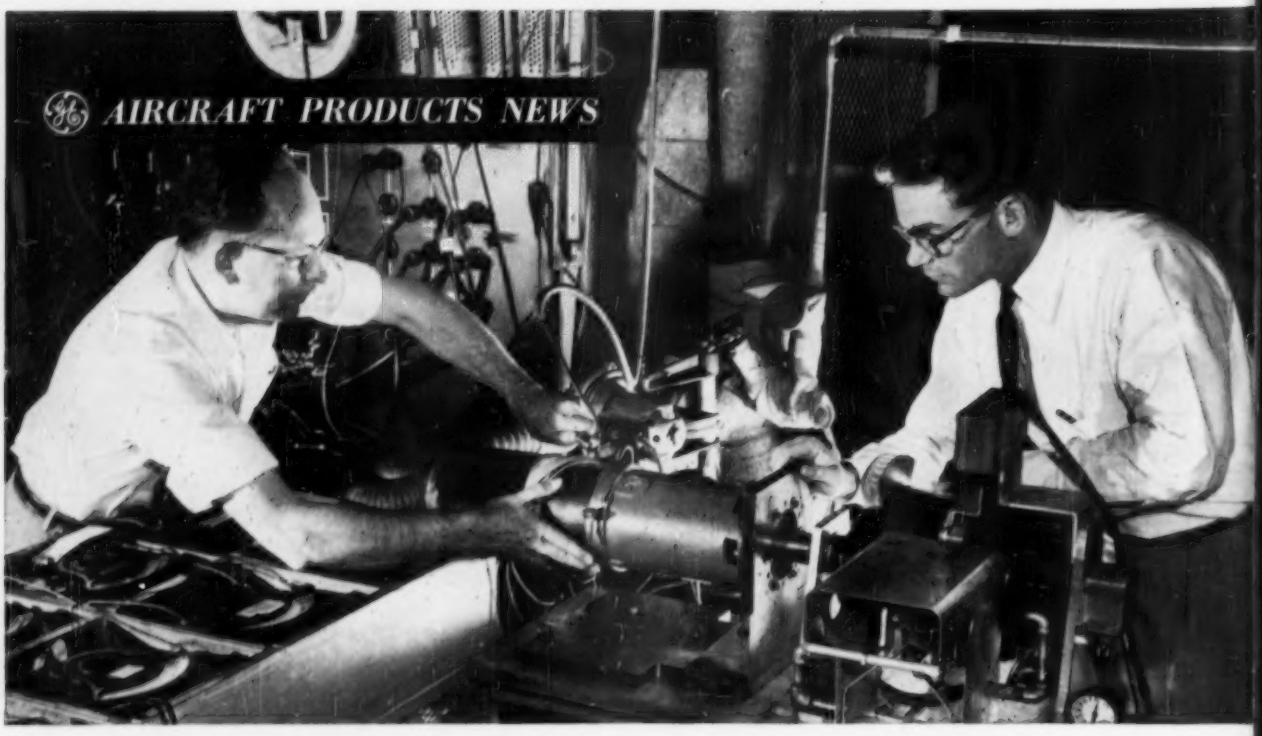
Sure there is test flying going on all over the place on all manner of projects. But there are two drawbacks to this. For one thing it is difficult to test bits and pieces by themselves and then properly evaluate their relationship to an entire system. Second, as regards airlines, the testing may not be done with an eye to airline operational problems.

It would appear that we could very well use an airline flight test group to evaluate various devices for commercial use. This might mean instruments, radios, lighting or what have you. Furthermore there is an urgent need for an airport at which all the various devices and techniques could be tested under actual conditions. For many years competent pilots have contended that we can fly safely in all weather conditions. But as yet we have no airport properly implemented to prove or disprove this possibility.

Serious Drawback

It has always been the practice to install a new system at a regular terminal and, after a certain amount of testing, ask for comments from pilot users. This has one serious drawback—many pilots may not be acquainted with alternate possibilities and therefore have nothing with which to make a fair comparison. Such a method was used a few years ago to prove that a notoriously bad type of approach lighting was desired. Never having seen the other configurations many pilots liked the first bright lights they saw. A lighted beer sign at some of our darker airports would have received the same welcome.

An experimental airport is, of course, one of the recommendations of the Curtis Report—all of aviation would gain from such an installation. The Andrews project is now over since equipment—and the runway—had to be returned. There is much work yet to be done with runway lighting. By taking the lead and pushing for more of this operational test flying I am sure the airlines would benefit greatly in the long run.



General Electric Missile Alternators Feature Light Weight, Low Harmonic Distortion, Close Voltage Regulation

High accuracy and reliability under extremes of environment has been attained by General Electric alternators for missiles and advanced aircraft. A wide variety of package systems including alternator, regulator and exciter have been designed in ratings from 4 to 10 KVA, operating at speeds of 12,000, 24,000 and higher rpm and at 400-cycle frequencies and above.

Typical of these advanced systems is the 27-pound alternator shown on test above. Rated 10 KVA with an overload capacity to 13 KVA, this 12,000-rpm machine is coupled to the drive source through an external splined shaft. A wide variety of prime movers including d-c motors, hydraulic and air turbine drives can be used.

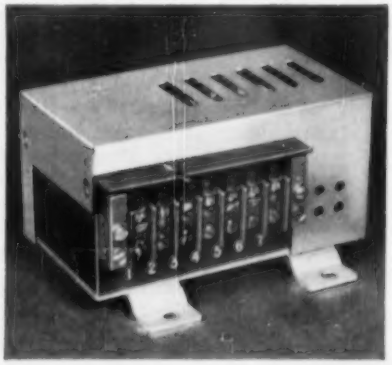
The 115/200-V, 400-cycle, 3-phase alternator has wound field construction, allowing close output voltage regulation under widely varying load conditions. The rotor is capable of withstanding 50% overspeed at temperatures up to 500 F. Total RMS harmonic content of the alternator output is less than 1% of fundamental.

The machine's power factor rating is .80 and it has an efficiency of 85% at rated load. Forced air cooling of approximately five pounds per minute, resulting in a six-inch H_2O pressure drop at sea level, enables the machine to deliver rated output continuously from 0 to 80,000 feet.

Completely self-contained, this machine requires no external excitation power. The alternator and exciter are combined on a single shaft and enclosed in one compact package.

The 800-cycle exciter supplies power to the voltage regulator which is then fed to the main alternator field in varying amounts to maintain constant voltage output. The magnetic amplifier-type, voltage regulator is completely static and is also self-contained. It provides less than 2% voltage regulation over 0 to 10 KVA load, 11,500 to 13,000 rpm speed range and at temperatures ranging from −50 to 300 F.

For more information or assistance in solving your missile or aircraft electric power supply problems, contact your local General Electric Aviation and Defense Industries Sales Representative.



General Electric regulator (left) and alternator (right) combine to form a 30-pound power package rated at 10 KVA. The alternator is 9¼ inches in length and 6 inches in diameter. The voltage regulator is 5 inches long. Total RMS harmonic content of the alternator output is less than 1% of fundamental. The generator has an efficiency of 85% at rated load.

New, Self-Contained Missile Accessory Power System Gives Both Hydraulic and Electric Power

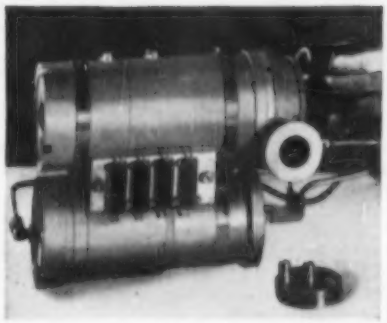
A completely self-contained, General Electric auxiliary power unit is now available to provide simultaneous hydraulic and electric power for missile systems. A current model based on this advanced design uses two alternators and a hydraulic pump to furnish 1000 watts of 400-cycle, 115-volt, 3-phase ac power; 100 watts of 2400-cycle, 115-volt, single-phase ac power and hydraulic pressure at 2200 psi and 4.75 gpm. Frequency control of both electric power systems is within ± 1% and voltage control within ± 5%.

A complete unit weighs 35 pounds or less and all components, including turbodrive and fuel tank, are contained within two cylinders, each 4½ inches in diameter and 13 inches in length. These cylinders can be mounted side by side or in-line.

A monopropellant fuel such as ethylene oxide spins the turbine wheel and provides the drive power for the alternators and pump. A cartridge ignition system activates the fuel and also provides a starting acceleration boost to bring the unit to rated speed and output within a half second. The fuel tank contains an integral pressure system utilizing hot gas from the decomposition chamber to activate a step piston. This eliminates the need for pressurization, pumps or plumbing external to the unit.

Fine frequency control is obtained with a load control loop consisting of a frequency detector, a loading alternator and parasitic loading resistance. Constant speed is maintained by placing a biasing torque on the turbine shaft to balance changes in load demands.

The advantages of this advanced missile APU can be easily applied to your particular problem. The modular design allows modification for a wide variety of applications by attaching matched hydraulic and electric components rated as required to a choice of turbodrives. Fuel tank size can be varied to provide operating cycles from 20 to 347 seconds depending on the turbine and output components used. For more information on this advanced missile power system contact your local General Electric Aviation and Defense Industries Sales Representative.



New, General Electric modular APU demonstrates an advanced design combining several electric and hydraulic power sources into one compact, completely self-contained unit. This particular version, with two electric power sources, weighs only 30 pounds, including fuel.

Whether 10 or 10,000 hours, General Electric pulse-forming network capacitors are engineered for the life span of your specific application. Thirteen-year accumulation of test data helps General Electric engineers meet your special conditions.

How 13 Years' Application Experience Can Help Solve Your Pulse-Forming Network Problems

Since 1944, General Electric has been designing, building and testing capacitor pulse-forming networks of practically every type. A wide variety of data and experience has been accumulated on temperatures, voltages, dielectrics and the other factors that affect service life and reliability.

Today, this wealth of accumulated data and experience can help solve your particular problems. General Electric pulse-forming networks can be designed and produced to meet service life requirements of 10 to 10,000 hours or more. Pulse width, rise time, number of pulses per second, ripple, and most other requirements can be met with solutions based on accumulated data and experience. Data on multiple width networks and size reductions based on forced air circulation is also available.

Quality manufacture gives General Electric pulse-forming networks the dependability required for missile applications. Capacitor sections are constructed of low-loss kraft paper and high purity aluminum foil. Inductance coils are wound on threaded forms for stability throughout the life of the unit. Highest quality mineral oil is used for impregnation. Strong, hermetically sealed cases help protect all components.

For more information on pulse-forming networks, networks proven in thousands of applications, contact your local General Electric Aviation and Defense Industries Sales Representative or write for bulletin GEA-4996, General Electric Company, Section 210-108, Schenectady 5, New York.

Progress Is Our Most Important Product

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SKYHAWK flight photo demonstrates small size of the "midget" attack bombers.

A4D Design Opposes Complexity Trend

By Irving Stone

El Segundo—Simplification and low-cost concept underlying the Douglas carrier-based A4D "midget" attack-bomber fits the philosophy behind economy measures now being projected for the aviation industry.

Although established five years ago, this design approach for the A4D Skyhawk, smallest and lightest of U. S. jet combat planes, brings these advantages:

- **More aircraft** for given investment.
- **Shorter** production time.
- **Increased** performance.
- **Easier handling** on carriers.
- **Ease** of maintenance.
- **Fewer** spare parts.

Original requirements for a high-performance carrier-based attack plane specified atomic bomb delivery, non-nuclear interdiction missions similar to role played by piston-powered AD types in Korea, combat radius of 300 nautical miles, 500 kt. V_{max}, and 30,000 lb. maximum permissible weight.

Design Schedule

Led by Edward H. Heinemann, chief engineer, Douglas El Segundo designers took a fresh approach to overcome the trend toward increased weight and complexity which boosts costs, development and production time. After six months of negotiation with Navy Bureau of Aeronautics, A4D design evolved with V_{max} of 590 kt., combat radius was stretched to 400 nautical miles, gross weight was pared to under 15,000 lb.

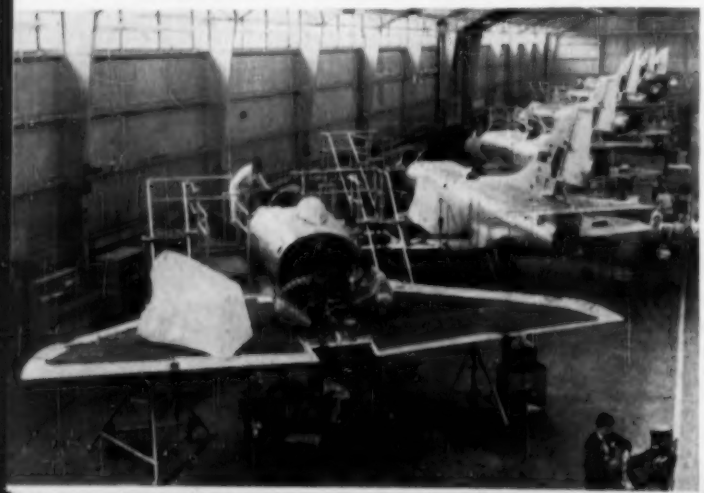
First A4D flew 20 months after BuAer inspected the mockup in October, 1952. First delivery of the A4D to the fleet was on Oct. 26, 1956, only 48 months after start of engineering design, considered a new record for recent high-performance jet aircraft.

Requirements were substantially met. Plane has flown at 587 kt. Basic takeoff gross weight with gasoline for fuel was 14,400 lb. Now, with switch to JP4 and additional equipment, basic takeoff gross is 15,500 lb.

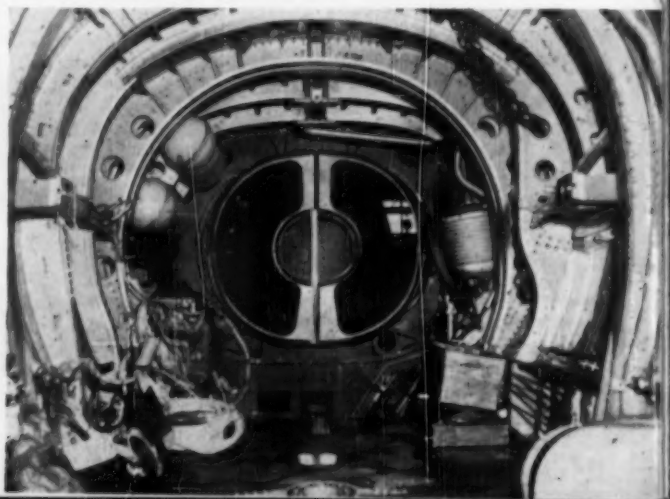
Accent on structural design simplicity not only keeps weight down, but also eases manufacturing problems. Compared to the earlier AD types, A4D only has about one-third as many structural detail parts.

Structure is broken down into four major assemblies—forward fuselage, aft fuselage, wing and stabilizer. This division would permit manufacture of

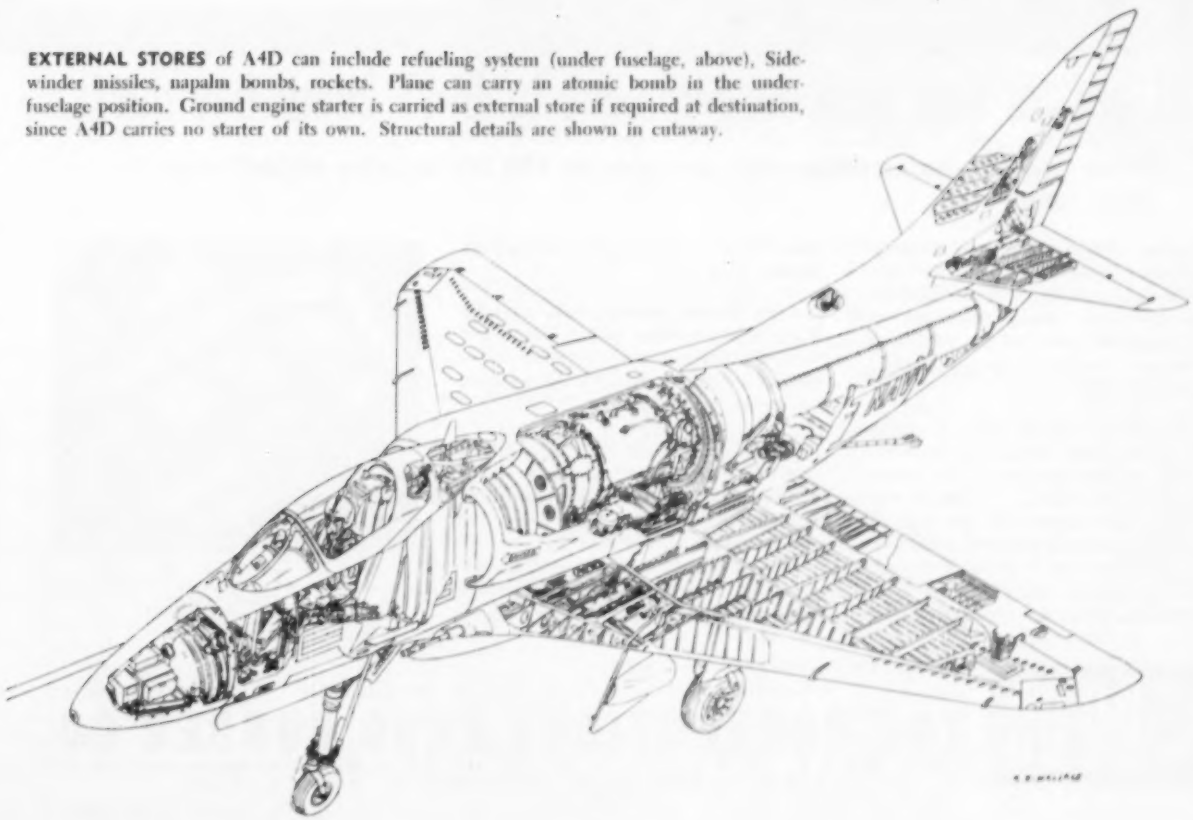
COMPLETE WING is mated to A4D fuselage sections in final assembly.

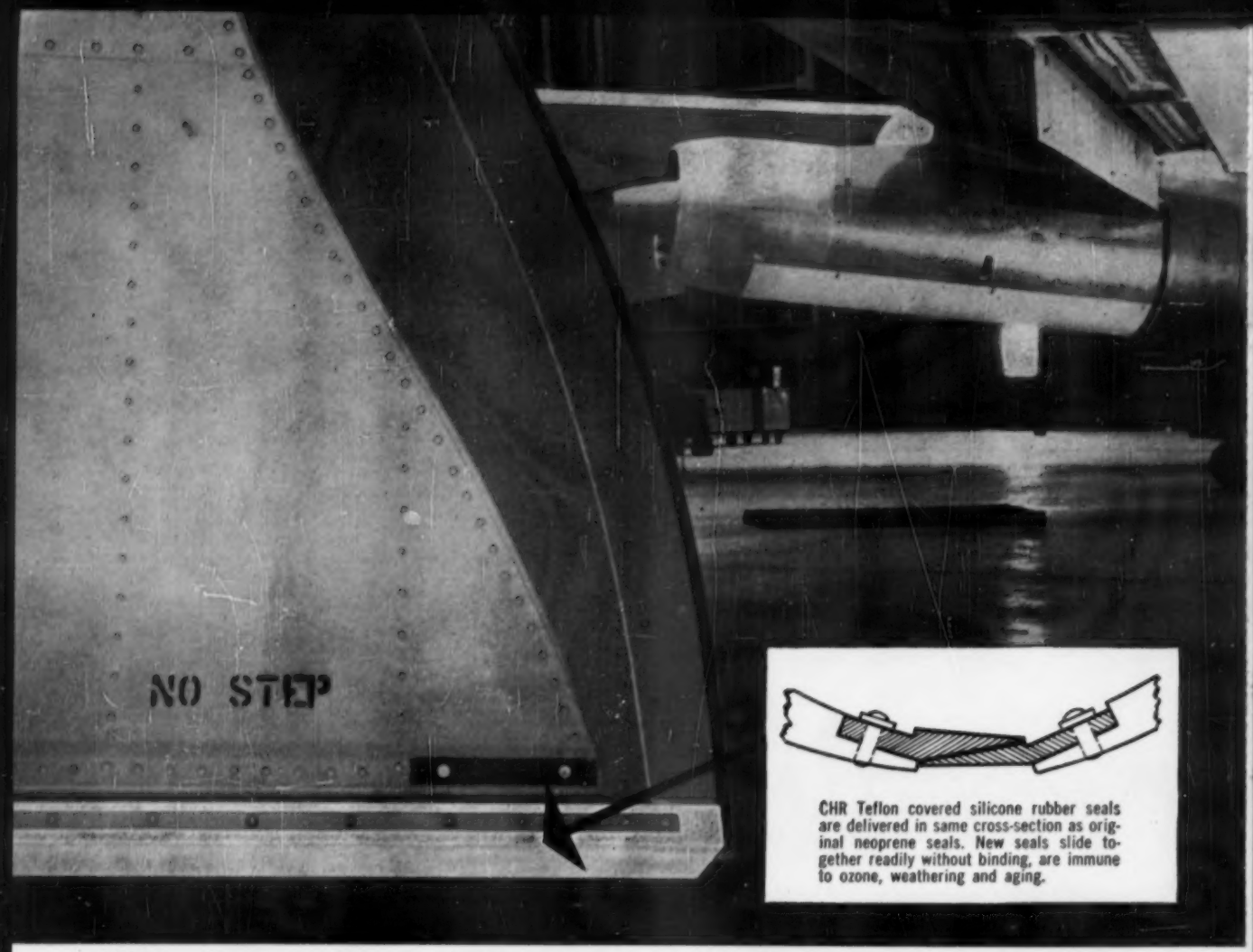


FUSELAGE INTERIOR, looking forward, shows deep bulkhead surrounding engine air intake openings.



EXTERNAL STORES of A4D can include refueling system (under fuselage, above), Sidewinder missiles, napalm bombs, rockets. Plane can carry an atomic bomb in the underfuselage position. Ground engine starter is carried as external store if required at destination, since A4D carries no starter of its own. Structural details are shown in cutaway.





CHR Teflon covered silicone rubber seals are delivered in same cross-section as original neoprene seals. New seals slide together readily without binding, are immune to ozone, weathering and aging.

CHR adapts new seal development to B-47 bomb bay doors.

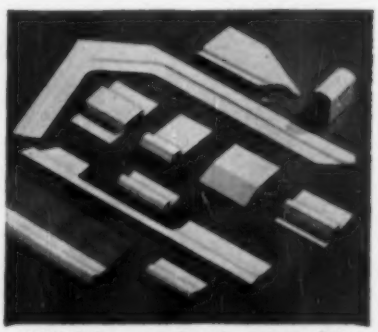
Teflon covered silicone rubber seals developed by CHR are replacing original neoprene seals. Here's why . . .

Extreme low temperature operating conditions played havoc with the neoprene rubber seals originally designed for B-47 bomb bay doors. Hardened by aging and cold, many of the seals split and ripped off when doors were opened and shut in flight.

CHR Teflon covered silicone rubber seals shown above solved the problem. Silicone rubber is immune to ozone, weathering and aging. The almost frictionless Teflon surface permits seals to mate readily without cracking or binding. The seals have -100°F to 500°F flexibility. They seal out and also shed water, ice and dirt. The white color provides reflective protection against radiation from nuclear weapons.

CHR Teflon covered seals are also being used on other planes where low friction, sliding action, abrasion resistance and resistance to fuels and synthetic lubricants is required.

Our experience in helping engineers with all types of airframe and engine seals utilizing all forms of silicone rubber reinforced with fabrics, Teflon and metals can be put to work for you. We solicit your inquiries for specific applications. Call or write. CHR field representatives are available for direct contact.



CHR Teflon covered seals are now being produced in many shapes and forms using all types of silicone rubber . . . solid, sponge and foam (COHRfoam).

CHR

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the four units at different locations with easy air or trailer shipment to a central point for final assembly, an important consideration in event of an all-out production effort.

Each major assembly is completed with equipment, miscellaneous installations, and provisions for relatively quick disconnect at mating points. For example, wing is completed, for joining to fuselage, with landing gear, control cables, electric wiring, control surfaces, fuel system piping, etc.

Structural material generally is 7075-T6 throughout, chosen because of its high-strength characteristics and availability in sheet, plate, extrusions and bar stock. Forgings have been avoided in the A4D, since these were considered by Douglas engineers to be relatively long-time procurement items.

Forward Fuselage

Fuselage nose is a metal section easily removed by manipulation of two latches. It encloses a Douglas-conceived integrated avionic package—communications, navigation and identification equipment—mounted on firewall with four quick-disconnect latches. Package, built by Packard-Bell, saves 48 lb. compared with corresponding equipment ordinarily used in carrier-based attack bombers, Douglas engineers say.

Cockpit is designed to afford maximum internal space within a minimum external shape. This is achieved through use of heavy skin (0.1 in.) carrying no internal stiffeners, affording cockpit room out to the loft line. Heavy skin also affords some flak protection.

Instrument panel support-frame is a single-piece formed channel section extending from keel to cockpit rail. Keel is a sheet metal angle in cockpit area, changing to channel extrusion aft of cockpit up to the fuselage breakpoint at about two-thirds wing chord.

Cockpit floor is comprised of .040 web with 1 by 1-in. stiffeners.

Light Seat

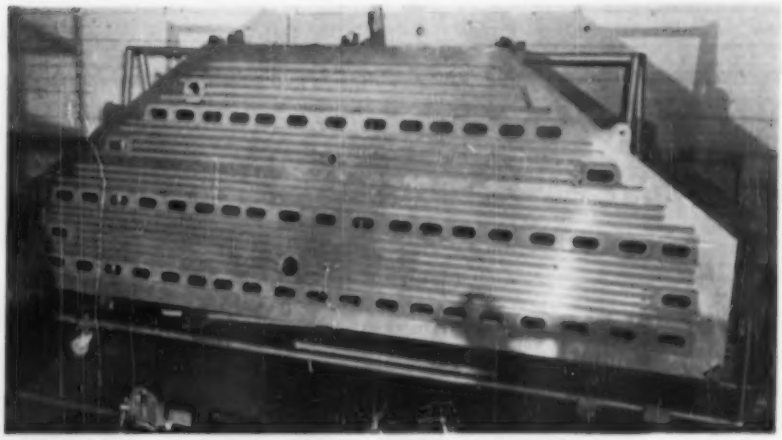
Ejection seat contains only about 80 parts, weighs only 40 lb.—a weight-saving of approximately 59% compared with ejection seat containing 240 parts and weighing about 98 lb. in an earlier interceptor design.

Nose gear retracts forward into a center area below cockpit floor. Easily accessible space on each side of the opening accommodates air-conditioning equipment, control bellcranks and cables, fuze panels.

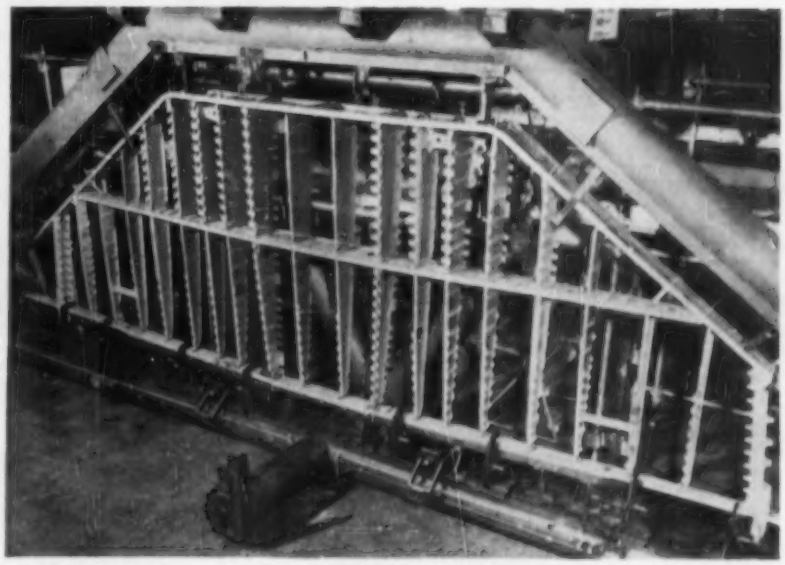
Nose gear strut attaches to vertical beams forming the inside of the equipment cavity.

Cockpit after bulkhead is light-gage continuous sheet incorporating ejection seat rails on forward side, hat-section stiffeners on aft side to withstand fuel tank pressures during arrested landings, sloshing loads and burst pressures resulting from gunfire.

Self-sealing tank behind cockpit bulkhead extends to forward end of engine compartment. Skin enclosing self-sealing fuel tank area is about .040 in. thick, carries channel-section stiffeners about 3 in. deep to take loads corresponding to those imposed on bulkhead and shear and bending loads imposed by forward fuselage structure.



SKIN of upper wing contains uniform openings sealed with O-rings.



WING BOX structure of A4D is integral fuel tank almost tip-to-tip. Spars, machined from plate, reduce possible leak paths.

Sheet Metal Bulkhead

Elliptical bulkhead separating fuel tank area from engine compartment is a built-up sheet metal channel member about 10 in. deep. It takes tank hydrostatic pressures due to catapult and sloshing loads, carries forward wing-to-fuselage attach loads, and supports jet engine air intake ducts, which begin about half way aft from front of fuselage tank area. This bulkhead also transmits shear from forward fuselage skin, which forms the inner surface of the intake duct, to the fuselage skin extending aft from the lip of the intake duct.

Attached to the bulkhead is a sheet metal web-stiffener combination extending to fuselage bottom to complete

A4D-2 Basic Data

Length	39.4 ft.
Wing Span	27.5 ft.
Height	15 ft.
Normal T.O. Gross Weight	15,000 lb.
Wing Area	260 sq. ft.
Horizontal Tail Area	48.85 sq. ft.
Vertical Tail Area, Total	49.95 sq. ft.
Chord at Wing Root	186 in.
Chord at Tip	42 in.
Sweep, 25% Chord	33.21 deg.
Aspect Ratio	2.91

Powerplant: Wright Aeronautical Corp. J65-W-4 turbojet weighing 2,750 lb.

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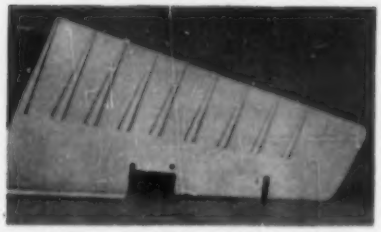


TADPOLE rudder has single sheet for trailing edge.

the separation of fuselage fuel tank and engine compartments.

Section Connections

Lightweight skin (.025) between cockpit rails, from engine compartment forward bulkhead back to fuselage breakpoint, has longitudinal extruded bulb angle stiffeners which carry axial loads to four tension bolts in bathtub fittings connecting fuselage forward section to aft section.

Skin from cockpit rails down to keel members is .064 in. material stiffened by vertical rolled Z-sections. Verticals were used in this area because of better shear allowables than obtained with longitudinal stiffeners.

Between engine compartment forward bulkhead and fuselage breakpoint are two major frames for connection to wing front and intermediate spares. Frame connecting to the intermediate spar is located at fuselage breakpoint and is a single-piece forging redesigned from a built-up member to ease producibility of the particular part.

Aft Fuselage

Fuselage aft section, housing engine tailcone and tailpipe, embodies stiffener construction similar to that in forward fuselage between engine compartment forward bulkhead and breakpoint. Makeup generally consists of light channels about 2½ in. deep, about 15 in. apart, with two Z-section vertical stiffeners spaced between.

There are three major frames in fuselage aft section—one for connection to wing rear spar, another for carrying arresting hook vertical and side loads and a third frame (forging) which connects to fin spar and also carries pivot connection for horizontal stabilizer.

Fin and dorsal are built integral with fuselage. Fin is a simple single-spar unit with spar made of bar stock routed into a channel. Ribs are single-piece light-gage sheet metal attached directly to fin leading edge.

Rudder is a trailing edge splitter plate type known as a "tadpole" because of its chordwise shape. Leading edge skin terminates at about 50% of total rudder chord. From this point aft, rudder is comprised of a center strip of .040 sheet stiffened on each side by chordwise-tapered hat-sections spaced on 8-in. centers. This arrangement is incorporated in the A4D-2 to prevent rudder flutter.

Height of aft fuselage section above ground eliminates need for tail bumper, saving considerable weight and complexity.

Wing Plan

Wing is a non-folding configuration because it has only a 27.5-ft. span. This saves weight and complexity in joints and fold mechanism, promotes safety and minimizes maintenance.

Wing planform is a modified delta. Structures incorporates a three-spar box with spars, skin and stringers all continuous almost tip-to-tip. Planview taper of the wing box, coupled with stringer configuration, affords a constant stress level which eliminates requirement for using a tapered skin.

Skin is .064 in. thick, 27 ft. long, 8 ft. wide, and is the largest thin-gage sheet ever rolled.

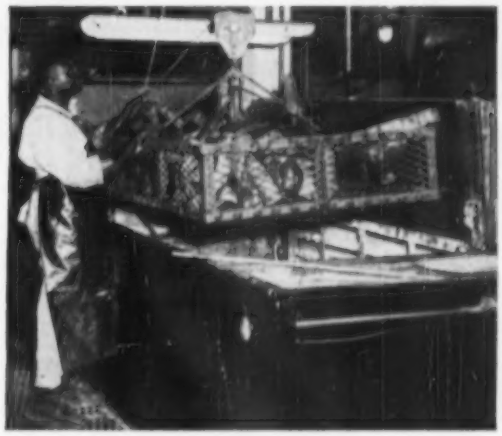
Overall continuity feature is important because entire box structure, almost tip-to-tip, is an integral fuel tank. The design affords simplicity, light weight and tank sealing integrity because of the minimum number of leak paths.

All equipment and adjacent structure

Oakite now gives a lift to aviation cleaning

All the industrial cleaning experience, all the research and service for which Oakite is famous now works for the aviation industry, too. This assures speed, a thorough job, and economy in maintenance cleaning. For example . . .

OAKITE SATUROL TRADE-MARK **cuts carbon cold**



A 10 to 30 minute soak in this safe, high flash point solvent material softens, loosens carbon for easy rinsing with water or kerosene. No heat needed. Suitable for any metal, it quickly prepares parts for overhaul. Built-in vapor seal prevents wasteful evaporation. It's just one of many Oakite quality cleaning compounds, available nationwide, along with technical service.

New Bulletin F-10059 tells about other up-to-the-minute Oakite materials and methods for specific aviation cleaning problems. Write Oakite Products, Inc., 55 Rector Street, New York 6, N. Y.

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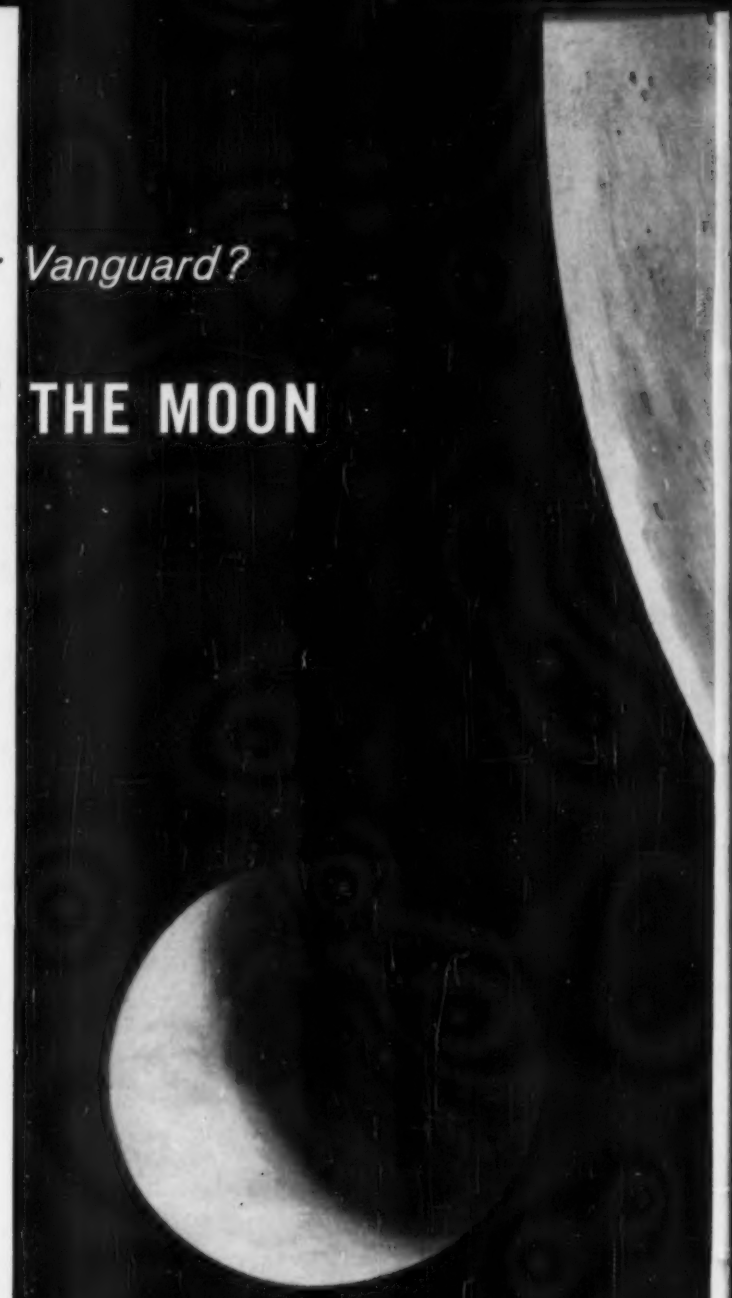
Next logical step after Vanguard?

THE FAR SIDE OF THE MOON



We don't know what we'll find there—it's the side of the moon we never see.

Yet, after Project Vanguard, a flight to the moon—and a look at its far side—would be the next logical step in our penetration of outer space.

To make this step, we must solve the problem of guidance: How do you direct a rocket out and around the moon and then back to earth?

The most promising method to date would include the use of inertial guidance systems such as Honeywell has helped pioneer and develop.

Honeywell's inertial guidance systems consist of ultra-precise gyros, accelerometers, computers and associated electronics that enable a missile to know where it is and how to reach its destination by "remembering" where it started from and where it wants to go. It provides guidance far beyond the reach of radio or radar.

Pioneering in the research, design and production of airborne controls has given Honeywell Aero the advanced technical competence you can rely upon in the solution of your airborne control problems. Contact Minneapolis-Honeywell, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13, Minnesota for valuable assistance—from original planning to final production.

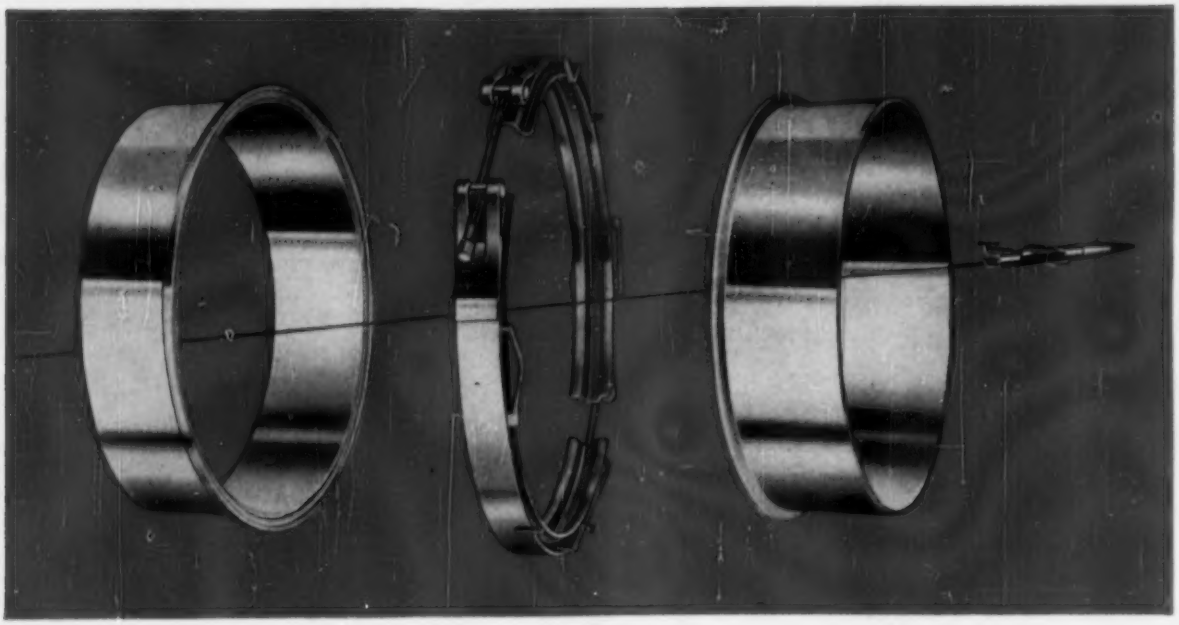
Actual photo of the Honeywell space reference system designed for Project Vanguard. This Honeywell inertial-type guidance system will guide stages one and two of the Martin-designed earth satellite launching vehicles. Third stages will then cut loose to position satellites in their orbits.

Honeywell

H Aeronautical Division

NEW MARMAN CONOSEAL TUBING JOINT

ASSURES PERFECT FLUID LINE SEAL AT EXTREME TEMPERATURES AND PRESSURES



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FUEL SYSTEMS

Operating Range	Temperature Range (° F.)	Max. Pressure (3" Size @ 70° F.)
Low	−300 to +750	1300 psig.
Medium	−300 to +1000	3300 psig.
High	−300 to +1600	testing still in progress

A 2½" Conoseal Joint has been tested with end restraint up to 6,000 psig.

Problems of connecting tubing and ducting of dissimilar metals subject to extreme temperatures can be solved with the new Marman Conoseal Tubing Joint. An all-metal joint, it provides metal gasket compression with the flexibility and sealing qualities formerly obtained only through use of organic seals. The Conoseal Joint withstands axial deflections up to 1/16-inch without sacrificing a perfect seal. The seal is maintained under extreme pressures and temperatures even on joints with material transitions, in which steel and aluminum alloy plumbing are joined.

The Conoseal Tubing Joint is available in three different operating performance ranges to meet varied applications. Standard sizes from 1" to 12" O.D. tube size, with special sizes designed to your requirements. Write today for full engineering details.

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is attached to wing box without affecting tank seal. Thus, fittings are attached to the box structure and sealed on the inside along with the tank. Nose rib fittings, for example, are sabre bolts sealed to the tank inside and providing attachment means for nose ribs on outside.

This promotes easy rib replacements, insures tank integrity.

Integral Fittings

All spars, actually channel-section shear webs, are machined from 2-in.-thick plate. This is to reduce all leak paths and parts to a minimum. Wing-to-fuselage and landing gear attach fittings are machined integrally with spars. Front spar is machined straight, then bent in heated die to conform to wing sweep.

Skin stiffeners are Z-section extrusions riveted to the skin by NACA-type rivets for efficient sealing. Stiffeners are attached to wing bulkheads by aluminum alloy bolts and nuts to save weight.

Bulkheads, consisting of sheet metal web with extruded T-section caps and extruded bulb angle stiffeners, are attached to the skin with shear tabs only where required. In aft portion of wing, bulkheads generally are attached only to outstanding flange of the Z-section stiffener. This procedure, while requiring close tooling control, eliminates bulkhead-to-stiffener attach clips and simplifies manufacure.

Access Openings

Access to wing box for assembly and tank maintenance is through numerous uniformly located openings (about 5 by 10 in.) in upper wing surface, chosen because of better fatigue insurance, since upper skin is in compression rather than tension. Also, upper skin openings are less susceptible to leakage than bottom openings.

Number of small openings rather than fewer large openings affords improved tank load-carrying capabilities, easier and quicker tank maintenance. Another benefit is that all access doors are same size, hence interchangeable and are themselves self-sealing with integral O-rings.

Leading edge wing slat requires no actuating mechanism, is operated aerodynamically in accordance with flight conditions.

Leading edge root section, external to wing box, encloses 20 mm. cannon, also houses main landing gear wheel in retracted position and encloses retractable catapult hook. In wing root section on starboard side an emergency drop-out wind-driven generator is stowed.

Landing gear retracts forward, eliminates need for emergency extension devices, since gear will free-fall and lock in position from force of airstream. (Nose gear also retracts forward and free-falls for emergency extension.)

Wing is a complete structure containing all installations, attaches to fuselage major frames with ten steel tension bolts at leading edge root section intercostal, front spar, intermediate spar, rear spar, and trailing edge channel section.

Portion of continuous wing box fuel tank beneath turbine section of the engine is shielded with .008-in. stainless steel bonded to wing top skin.

External Stores

Three places on wing undersurface—on fuselage center and 75 in. each side of center—have structural provisions to carry many types of external stores, including atomic bomb (on centerline), missiles (Sidewinder), napalm bombs, rockets and in-flight refueling store when aircraft serves as a buddy system tanker. Since the aircraft carries no engine starter, relying on Douglas-designed ground starter, provision is made to carry this ground unit as an external store if it will be required at destination.

Modified delta horizontal stabilizer is pivoted at front spar, actuated at rear spar. Upper skin is .125 in., lower skin .160. Each skin is stiffened with an internal sheet, .312 in. thick, routed into a waffle pattern which serves for stringers, bulkhead cap material and bonding material. This arrangement was dictated by thinness of stabilizer section and to minimize parts and assembly.

All control surfaces, except rudder, are constant chord.

Maintenance Requirements

A4D has lower maintenance man-hour requirement than any other modern tactical jet aircraft, Douglas maintenance engineers say, requiring 26.7 maintenance manhours per flight hour according to fleet experience. This is claimed to be 35% less than any other aircraft of similar performance in the attack category.

Bulk of test and support equipment, including tools, are standard off-the-shelf items.

Cockpit instrumentation is installed to permit very fast access for replacement of individual units.

Nose wheel well contains primary

A4D Buddy Store

Douglas El Segundo Division has developed self-contained buddy store for conversion of A4D to tanks service (AW Mar. 25, p. 97). Store incorporates own air-powered turbine, hydraulic and electrical systems, fuel tank and collapsible drogue. A4D-2 is fitted with refueling probe which extends 34 in. beyond nose and feeds into self-sealing tank behind cockpit.

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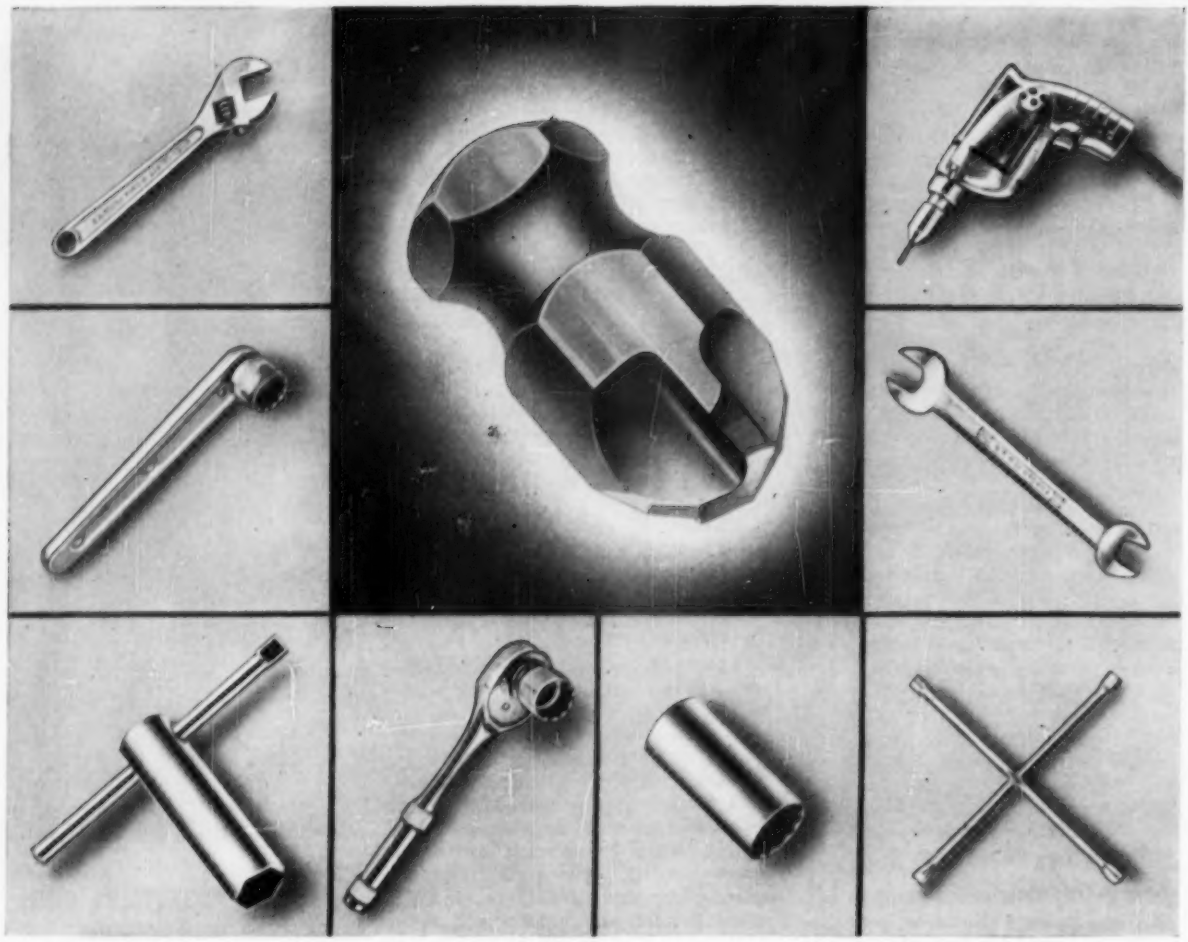

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power panel on one side, air-conditioning equipment on other side. This equipment is easily accessible through open areas, since there are no inspection plates or doors. In flight, with gear retracted, nose gear door seals against the component to protect the equipment.

Canopy actuating system consists of a simple open-and-close sequence. Canopy is held in open position with bungee cord.

Self-sealing fuel cell located aft of cockpit is accessible through fuselage crown inspection plate. Removal of this plate and tank cover plate, together with inspection and closing up, can be done in about one hour.

Fuselage breakpoint for J65 engine removal can be separated in about half hour by three or four men by unbolting four main bolts. Without breaking the fuselage joint, about 75% of the engine accessories and other aircraft equipment are accessible through inspection plates on each side of fuselage.

Storage Considerations

Middle breakpoint characteristic of the plane is intended to comply with limited space aboard carriers. Fuselage rear section can be moved aft, then forward slantwise between nose and wing leading edge. Engine can then be removed and stored crosswise aft of wing. This arrangement permits deck storage almost within the block dimensions of the aircraft.

High cheek air inlet ducts for jet engine have reduced foreign matter damage to J65 more than 50% compared with other aircraft using nose intake for this engine, Douglas maintenance engineers declare.

Replacement of wing as a complete unit is relatively fast, does not involve center wing section-to-fuselage connection complications as in conventional configurations, also insures that there will be no wing panel misalignment as might occur when one wing panel is replaced as a result of damage.

Fuselage is not adapted to automatic riveting but majority of rivets are same diameter, minimizing problems associated with stocking parts and hand tools.

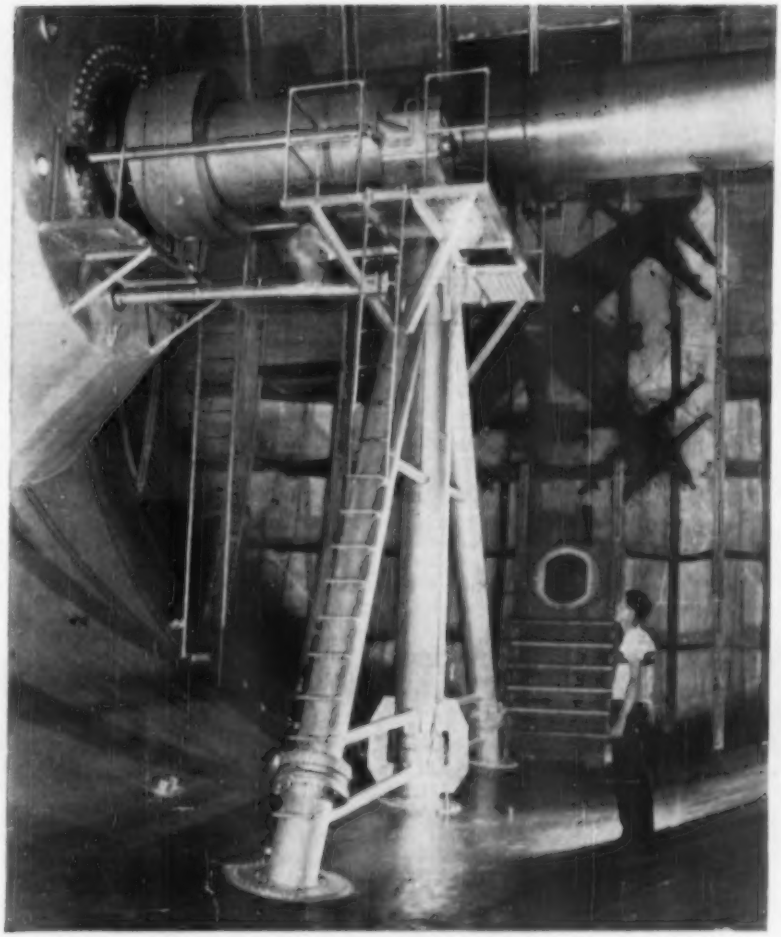
Attachment of upper and lower wing skins to Z-section stiffeners and upper skin to hand hold doublers is done on Drivmatic riveter. This operation involves about 11,000 rivets (5/32 in. dia.).

Wing bulkheads also use about 90% of 5/32-in. rivets in attachment of cap angles and vertical stiffener members to web. This work is done on Chicago automatic riveters.

On wing and fuselage installation lines, support platform is set so that its level (5 ft. 9 in.) accommodates average assembler's height so that he will not have to exert himself to reach work. This arrangement resulted from study to lessen worker fatigue, speed installation time. Platform also affords an upper working level, eliminates need for scaffolding.

Use of only four major components—forward fuselage, aft fuselage, wing and stabilizer—permits installation of associated equipment in each of these units on the production line, allows operational checkout before final assembly. This eliminates final installation line, necessitates only a short operational line for overall systems checks after various major assemblies are joined.

From beginning of initial assembly to flyaway time, elapsed manufacturing period will be 16 weeks at maximum production rate scheduled.

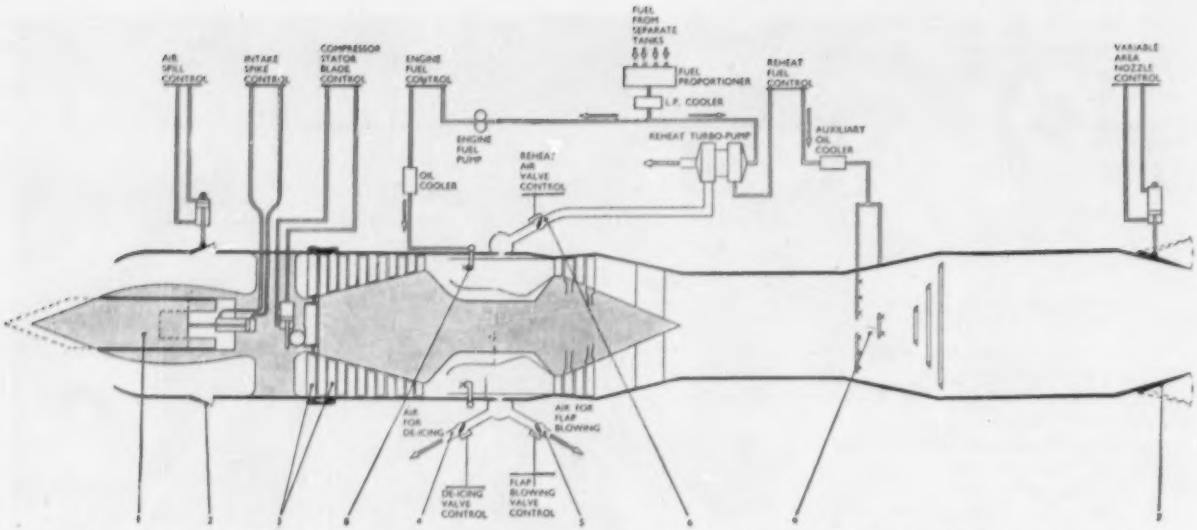


Fix Cuts Lewis Tunnel Vibration

Shaft support fix which NACA's Lewis Flight Propulsion Laboratory, Cleveland, Ohio, used to permit its 10 ft. x 10 ft. test section Mach 3.5 propulsion wind tunnel to start test work on schedule over a year ago. The additional support provided by this device kept the tunnel's main compressor drive shaft vibration within acceptable limits (0.005 in. amplitude) thereby gaining a year's operating time, valued at $1.5 million. The hydraulically positioned struts hold two 16 in. diameter rollers against the large shaft to steady it as it comes up to 875 rpm. speed and delivers 150,000 hp. to the main axial flow compressors. A small electric motor has been used to keep the large 183 ft. long shaft system turning slowly and continually so that a permanent sag in any one position wouldn't develop. Five Lewis Laboratory engineers received $400 each for their work on this modification which put the $32 million facility into business. During the first year's operation the 10 x 10 section has provided otherwise unobtainable data on the performance of Mach 2.0-Mach 3.5 powerplants. Best known of its projects was the evaluation of the J79 engine operating in a B-58 propulsion pod at just over Mach 2.

F-105 Goes to Eglin for Armament Testing

Republic F-105 Thunderchief fighter bomber arrived at Eglin AFB, Fla., for armament and fire control tests expected to last several weeks. Test aircraft was flown from California.



DE HAVILLAND layout for Mach 2.0-3.0 propulsive system: (1) movable spike inlet; (2) inlet air overflow spill doors to help match the inlet flow to the compressor; (3) variable inlet guide vanes and compressor stators; (4), (5), (6) air bleeds for de-icing, boundary layer control and pneumatically run reheat fuel pump; (7) variable area exit nozzle; (8) fuel flow to the main engine; (9) fuel flow to the afterburner. Basic turbojet, which resembles Gyron, is only relatively small part of system.

Gyron Fits Mach 3 Propulsion System

By Robert Cushman

Compared with complex high compression ratio split compressor and variable stator engines optimum for current Mach 0.8-2 flight, de Havilland's Gyron seems at first glance to be a backward step.

However, the complete picture of the propulsion system into which de Havilland visualizes blending the basic Gyron illustrates how turbojets will tend to become second-fiddle to supersonic inlets and ramjet-like afterburners as jet aircraft approach Mach 3 speeds.

In this layout, an engine similar to the Gyron though with one less compressor stage (see cutaway) is sandwiched between a supersonic inlet and ahead of a large afterburning section leading to a variable exhaust nozzle, the final portion of which can go fully divergent.

The basic Gyron (AW Aug. 19, p. 31) is a straight-forward engine. Other than the greater tip-to-hub ratio of the compressor and the fully annular combustion chamber, the Gyron looks like a larger version of some of the powerplants in the J47 era.

Earlier fixed-geometry, single-spool turbojets were of that design because engine designers had not developed the more complicated higher performance engines. But the Gyron has consciously been designed for speeds three times as great as the maximum attained by most of the earlier engines with superficially similar appearances.

The Gyron's task covers an extremely wide speed and altitude range. It must get an aircraft off the ground and to efficient speeds and altitudes both by providing thrust itself and by pumping air back so that the afterburner may operate. Then at Mach 2-3 speeds and 50,000-90,000 ft. altitudes the Gyron must resist the forces of truly high-performance flight. To cover this range, the compression ratio has purposely been made low, and therefore the engine simple, since at Mach 2.5-3 speeds the most important part of the compression has already been performed by

INNER AND OUTER flame tubes (left) from Gyron's fully annular combustion section illustrate use of reversing air chutes, skin tooling strips, large dilution air ports. Other components are variable inlet guide vane and typical compressor rotor blade and gudgeon pin assembly (center), and first and second stage turbine nozzle blades (right).

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As Vought had planned, a wind tunnel flutter test had to precede the upcoming high-speed flight. But Vought's prearranged date at a government tunnel was over a month away. The facility was booked solidly up to the appointed day. And Vought's own Mach 5 tunnel was under construction.

Then Ed revealed the scope of his liaison. It had ranged to the rocket test track at nearby Edwards Air Force Base. There, with the help of a cooperative track project engineer, Ed had spotted a rusting rocket sled, left behind from a radome test. Now, if the sled could be rigged to carry that spare Regulus fin, Ed figured, they might get flutter data before the tunnel test.

That changed Ed's state of liaison. All Vought was suddenly at *his* service. Shopmen reworked the sled to mount the fin. Instrumentation technicians fitted the fin with gages and transducers. Vought's top flutter men double-checked, raised their eyebrows, then endorsed the whole thing.

At the track, moments before the rockets exploded, Ed had a twinge of doubt. His sled was a monster, indeed. Air loads would be terrific . . .

Then the sled shot off on the first of two successful trips that revealed all the data required.

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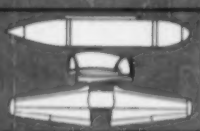	TANK-WING-MAJOR SUBASSEMBLY SUBCONTRACT PRODUCTION
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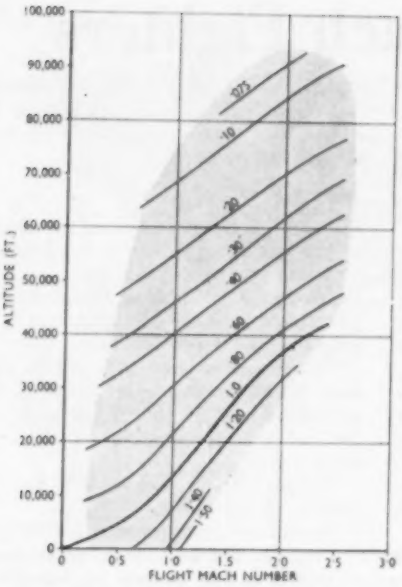


POSSIBLE flight envelope for a Gyron powered interceptor is shown in this de Havilland graph. Plot shows how fuel needed drops off sharply at high altitudes.

the aircraft inlet. Unfortunately, along with the pressure boost from the inlet goes a corresponding temperature boost (over 500F) which will be added to the compressor's own temperature rise so that the later compressor stages may have temperatures as high as those on the turbines of some early engines.

Test Problems

Although de Havilland said that its engine has passed static type tests it did not make it clear whether the Gyron had been fully checked out at realistic high Mach conditions. It seems unlikely that it has without help from facilities on this side of the Atlantic, for Britain is short on ground test facilities to simulate high Mach conditions on an engine of this size and none of the flying test beds mentioned in conjunction with the Gyron have this sort of capability.

The single rotor of the Gyron consists of a short seven-stage axial compressor and a two stage turbine joined by a large diameter trumpet shaped sheet metal shaft. It has purposely been made stiff enough so that it can be carried on only two bearings with the turbines overhung.

Compressor blading of the engine, rated at 20,000 lb. thrust without afterburner, is all-steel to withstand the high ram temperatures directed at it in supersonic flight. It is thin-sectioned for light weight. De Havilland said that the carbon pressure seal used at the rear of the compressor to keep the hot compressed gases of supersonic flight from leaking past to the engine's bearings has proved to be quite successful.

The combustion system is fully annular and uses upstream fuel injectors to keep the combustor and thus the whole short and light.

The two turbine stages have blades of fully machined Nimonic forgings using fir-tree attachments.

A major headache in the development program was the difficulty of obtaining an evenly distributed temperature profile on the turbine blades. Apparently the main difference between the D.Gy. 1 model and the D.Gy. 2 model is that on the latter fixes made in the combustion system dilution air ports improved the turbine inlet temperature distribution to the extent that the thrust output could be raised from 15,000 lb. to 20,000 lb.

Performance Estimate

From the general type of the engine and from comments made abroad, it may be roughly estimated that the D.Gy. 1 is a 250-270 lb. per sec. airflow engine with a compression ratio of 5 and a turbine inlet temperature of 1,500F while the D.Gy. 2 has an airflow just under 300 lb. per sec., a compression ratio of 6 and a turbine inlet temperature of 1,650F.

Another development problem was fatigue failures of the turbine blade root profile forms and the fir-tree serrations. It was determined that these failures were being caused by sixth order excitation in the first stage and by third order excitation in the second stage. When the number of fuel injectors was changed from 18 to 17 the stress flow was evenly distributed from blade to root and failures eliminated.

De Havilland uses shrouded Nimonic 90 first and second stage turbine blades in the lower thrust D.Gy. 1 but had to go to higher temperature Nimonic 100 blades on the first stage of the D.Gy. 2. The Nimonic 100 blades are unshrouded and have a much thicker profile near the blade root to resist the higher temperature fatigue conditions of the 20,000 lb. thrust D.Gy. 2.

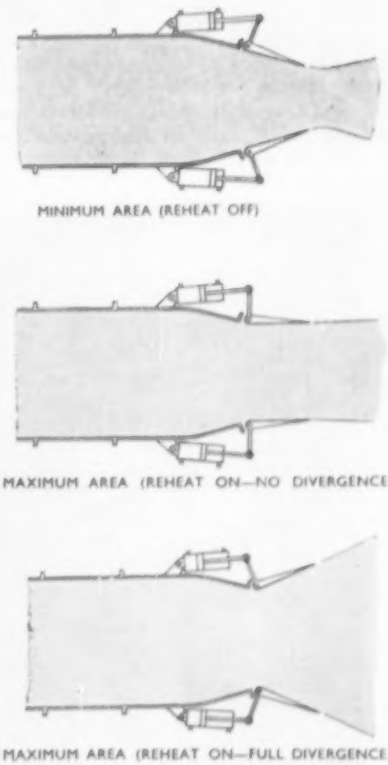
De Havilland said that it used the scaled down Gyron Junior to develop the compressor, combustion and turbine components and then scaled the results back up for the larger Gyron. The company also used this technique for air cooled turbine blades. Air cooling could bring the thrust potential of the large engine to 23,000 lb. dry and 30,000 lb. with afterburning.

To get around these devices, necessary because of lack of test facilities, de Havilland is expanding its Halford Laboratory at Hatfield to include a Mach 3.0 24 in. square wind tunnel for developing supersonic intake systems to go with the engine. It also is working on both mechanical petal-type converging-diverging exhaust nozzles and combination mechanical-aerodynamic exhaust nozzle in which air streams of angles to the main flow are used to aid in forming the jet.

As far as the control for a Mach 2.0-3.0 powerplant goes, de Havilland has found that in a variable geometry propulsive system with so many interacting degrees of freedom, control is just as important as the mechanical design. Accordingly the company is setting up an analog simulating unit on which results of the inlet shock investigations will be combined with static engine runs in an attempt to develop a stable, high response control system to operate automatically off a single pilot throttle lever.

Comparing the basic engine with a total supersonic propulsive system, the basic engine on a supersonic fighter represents less than half the length and half the controls. De Havilland points out that the fuel flow system must be so flexible that it will supply properly atomized fuel to the burners at rates which vary from 50% over that needed for takeoff, when flying at Mach 1.0 at sea level, to less than 10% of sea level when flying at 90,000 ft. altitude.

Despite the Gyron's high performance capabilities, government support was withdrawn when the policy of shifting to missiles was decided.



OPERATION of the de Havilland supersonic nozzle starting (top) on afterburner (middle) and at altitude (bottom).

SEPR Rockets Power French Fighters

By David A. Anderton

Paris—Production rocket engines cleared for flight in Sud Aviation's Trident II, Dassault's Mirage and a number of other French military and research aircraft now are being delivered by the Société d'Etude de la Propulsion par Réaction (SEPR).

All of these engines are basically the same, built around combustion chambers developing 3,300 lb. of thrust and using hypergolic (self-igniting) propellants. Current combination is nitric acid in 98.5% concentration and furaline.

Specific impulse of the engine is approximately 207 seconds.

Solid Propellants

Solid-propellant work at SEPR is increasing and now includes the production of booster and sustainer rocket engines for a variety of aircraft and missiles, a two-stage solid-fuel rocket for an air-to-air missile, igniters for ramjets and solid-propellant starters for gas turbines.

Backing up this impressive output is a test center at Melun-Villaroche rated as the finest in Europe, flight-test work at Melun, solid-propellant test stands at Istres in the South of France, fabrication facilities at Argenteuil near Paris and the design headquarters and scientific laboratories at Villejuif near Paris.

Total employment of SEPR is just under 1,000. Half are technicians.

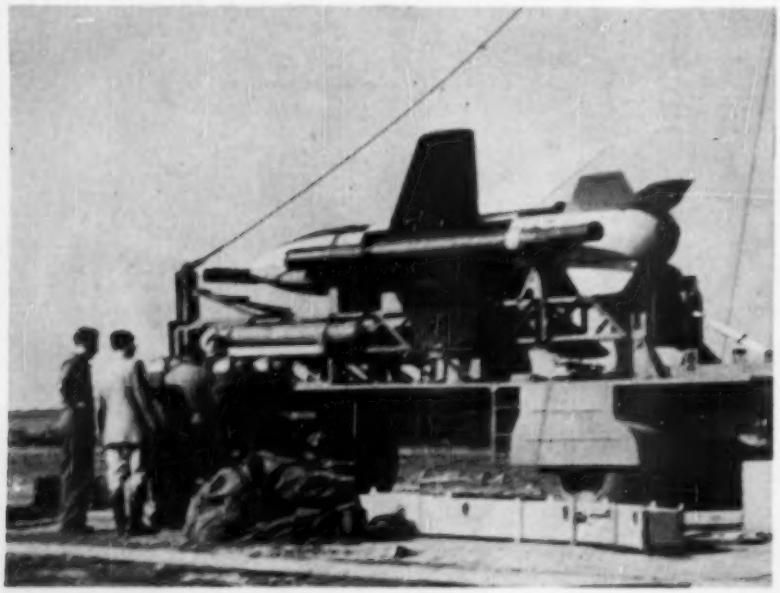
SEPR rockets have been powering French aircraft for about five years. First was a prototype SO. 6025 Espadon used in development flight test of the engine before installation in the Sud Aviation Trident I (AW Aug. 19, p. 50).

The Espadon made its first flight on June 10, 1952, and was the first French rocket-powered aircraft.

The Espadon engine has been developed successively through a number of variations, but each has had the combustion chamber design in common. This reflects the company's philosophy, which is to design a good combustion chamber and develop the engine around that as a building block. Improvements in performance are expected to be gained by fuel changes rather than by boosting chamber pressures, for example.

Two of these engines are now scheduled for installation in the Dassault Mirage III and the Sud Aviation Trident II:

- **SEPR 66, a single-chamber unit** developing 3,300 lb. thrust and installed in a jettisonable pan under the belly of the delta-winged Mirage. This powerplant supplements the main Atar turbojet with afterburner. It has been flown in a Dassault Mystère IV through an extensive flight test program.
- **SEPR 631, a two-barreled powerplant** giving 6,600 lb. thrust in two increments produced by firing one barrel at a time. This engine furnishes more than half the design thrust of the mixed-powerplant interceptor. It is a direct descendent of the SEPR 481 three-chambered unit used in the Trident I. Flight tests have been made with the 631 in the Trident II.



MATRA MISSILE on launcher-transporter is one of many missiles for which SEPR has furnished boosters or sustainer solid-propellant rockets.

SEPR 66

The Mirage engine is strung out along a nine-foot assembly which is intended to attach to the belly of the plane in a separate bay. Width of the packaged powerplant is about 24 inches and the height is just under one foot.

The engine is rated at 3,300 lb. sea level thrust, increasing to 3,600 lb. at an altitude of 39,360 ft. because of the reduced backpressure on the exhaust nozzle.

Weight of the unit is 308 lb. including all accessories.

Specific fuel consumption is 0.00525 lb. per lb. per sec. at sea level, and 0.0048 lb. per lb. per sec. at 39,360 ft. altitude.

This includes the fuel consumption of the turbopumps.

Cockpit installations are simple: a single power lever for starting or shutting down the engine, and the control unit which does the job automatically.

Mechanically, the rocket powerplant consists of an electrical starter, three feed pumps which supply the gas generator, a gas generator driving a turbine which drives the main fuel pumps, valves, jet pumps and the combustion chamber.

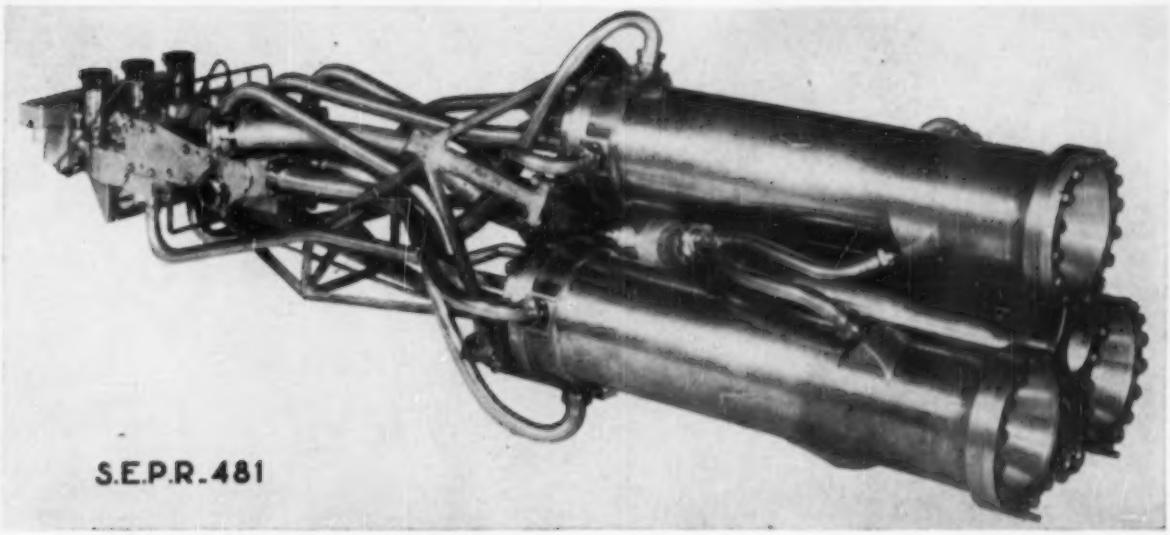
These components are packaged together with the necessary lines and conduits on a structure and the whole works supplied to the airframe manufacturer. Tank design requirements are specified by SEPR, but the tanks are fabricated by the airframe manufacturer. Small tanks are also required for water and methanol.

Firing Up

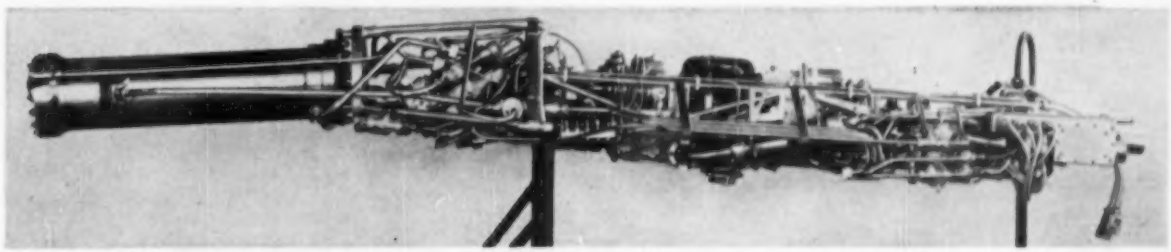
Starting sequence begins with the electrical starter driving the single-stage centrifugal feed pumps for the gas generator unit. There are three of these pumps, one each for acid, furaline and the water-methanol mix used to cool the gases and thus increase the life of the turbine. It takes about half a second for the pumps to build up pressure and then a pressure switch opens the lines to the generator.

Hot gases from the generator drive the single-stage impulse turbine which at its design rpm. drives the main feed pumps plus the three smaller pumps for the gas generator. The starter is switched off when the turbine gets up to speed.

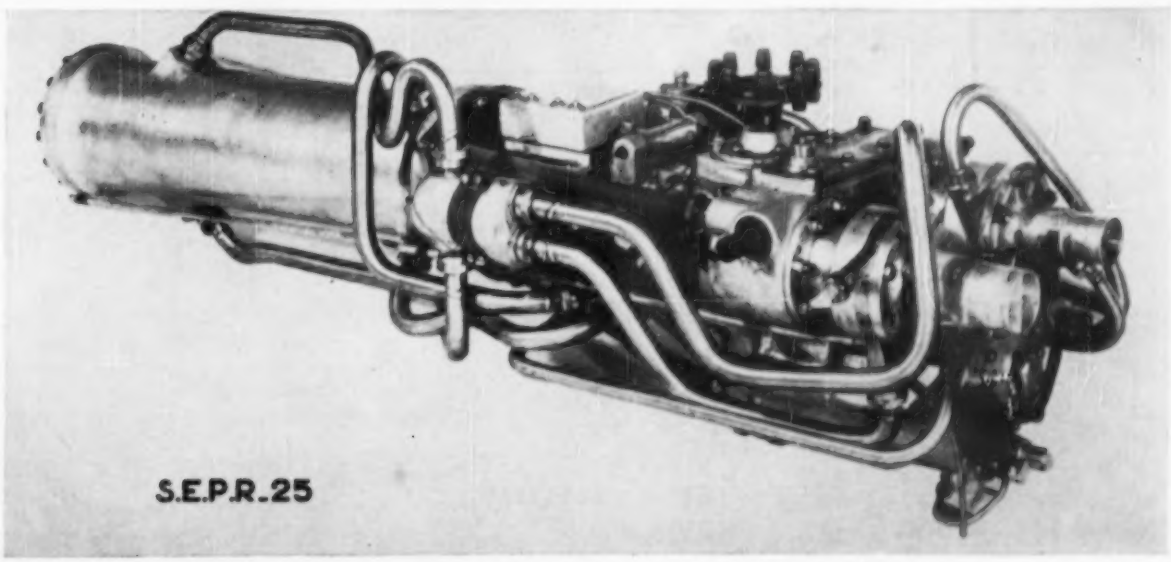
With the main feed pumps at pressure, another pressure switch opens the main propellant valves and the chamber



COMBUSTION CHAMBER assembly of SEPR 481 shows some of the details of this three-chambered engine developed as a prototype for the Sud Aviation Trident I. Each chamber is rated at 3,300 lb. thrust. Turbopump assembly was separate unit and is not shown here. Overall dimensions of the assembly shown: length, 70.3 in.; width, 24.4 in.; height, 24.4 in.



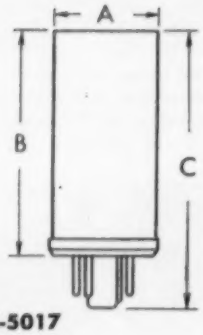
SEPR 66 rocket powerplant developed for Dassault Mirage series, is a single-chamber unit designed to be attached as a packaged powerplant. Thrust of the engine is 3,300 lb. Dimensions: length, 110.2 in.; width, 23.6 in.; height, 11.8 in. Weight of the unit, including all accessories, is 308 lb.



FIRST FRENCH liquid-propellant rocket to power an airplane was the SEPR 25, a 3,300-lb. thrust unit. Pumps were driven by shafts from the main turbojet powerplant of the SO. 6025 Espadon test vehicle. Package length of this engine was 60.0 in., width was 20.3 in. and height was 17.1 in.

Full Wave SILICON Tube Replacement RECTIFIERS

Where dependability and ruggedness are a "must," Full Wave Silicon Tube Replacement Rectifiers will solve your problems. One of the four standard types described below will meet the requirements of your application.



S-5011
1N1150

Maximum Rating:

Peak Inverse Voltage per Section ..... 1600 Volts Max.
Peak Rectifier Current per Section ..... 8000 MA Max.
DC Output Current ..... 750 MA Max.
Ambient Temperature ..... 100°C Max.

Dimensions:
A—1-1/2" O.D. B—2-1/4" C—2-27/32"
Four Pin Base
Replacement for Types 80, 82, 83, 83V, 5Z3

S-5017
1N1237

Maximum Rating:

Peak Inverse Voltage per Section ..... 1600 Volts Max.
Peak Rectifier Current per Section ..... 8000 MA Max.
DC Output Current ..... 750 MA Max.
Ambient Temperature ..... 100°C Max.

Dimensions:
A—1-3/16" O.D. B—2-19/32" C—3-5/32"
Octal base
Replacement for Types 0Z4, 5X4, 5Y4, 6AX5, 6X5

S-5018
1N1238

Maximum Ratings:

Peak Inverse Voltage per Section ..... 1600 Volts Max.
Peak Rectifier Current per Section ..... 8000 MA Max.
DC Output Current ..... 750 MA Max.
Ambient Temperature ..... 100°C Max.

Dimensions:
A—1-3/16" O.D. B—2-19/32" C—3-5/32"
Octal base
Replacement for Types 5AU4, 5AW4, 5AZ4, 5T4, 5U4, 5V4, 5W4, 5Y3, 5Z4

S-5019
1N1239

Maximum Ratings:

Peak Inverse Voltage per Section ..... 2800 Volts Max.
Peak Rectifier Current per Section ..... 5000 MA Max.
DC Output Current ..... 500 MA Max.
Ambient Temperature ..... 100°C Max.

Dimensions:
A—1-5/16" O.D. B—3-3/4" C—4-5/16"
Octal Base
Replacement for Type 5R4

Send for data sheets on any of the above types.

Sarkes Tarzian, INC. **RECTIFIER DIVISION**

DEPT. AW-4, 415 NORTH COLLEGE AVE., BLOOMINGTON, INDIANA

IN CANADA: 700 WESTON RD., TORONTO 9, TEL. ROGERS 2-7535
EXPORT: AD AURIEMA, INC., NEW YORK CITY

fires. Total time for the starting sequence is about three seconds.

For altitude operation, jet pumps are brought into use. These are mounted as part of the tank valves just downstream of the tank. The jet pumps are driven by a primary stream acting as an ejector and coming from the main fuel pumps. This pressurization upstream of the fuel feed pumps prevents cavitation at altitude.

Since the beginning of this year, the SEPR 66 unit has been fired more than 1,000 times both in flight and in static tests on the ground.

SEPR 481

This engine, developed for the Trident 1, is considered only a prototype unit. During its development program, it was fired in 1,200 tests in two and one-half years. Most of these were ground runs, but 120 were flight tests. Combustion chambers were fired approximately 2,700 times during the period.

The SEPR 481 has all the outward signs of a prototype engine; its packaging is not nearly so neat as the later models. In addition, the engine was made in two separated components at the request of Sud Aviation. The turbopump assembly was separated from the main body of the engine and located forward in the fuselage in the region of the wing trailing edge.

Because of the "boilerplate" nature of this engine, the specific impulse was lower than current engines, and varied from 185 to 190 seconds at sea level to a maximum of 208 at above 35,000 ft.

Weight of the combustion chamber assembly was 220 lb. and the turbopump component weighed 286 lb. Accessories accounted for another 62 lb.

Starting sequence and operation of this engine were basically the same as those described earlier for the SEPR 66 engine. But with the three chambers, the technique called for step-firing. Chamber 1 was ignited first, normally at takeoff, and then immediately shut down. It was lit again at about 29,500 ft. and climb continued. Second chamber was cut in at about 41,000 ft. and the third at 46,000 ft.

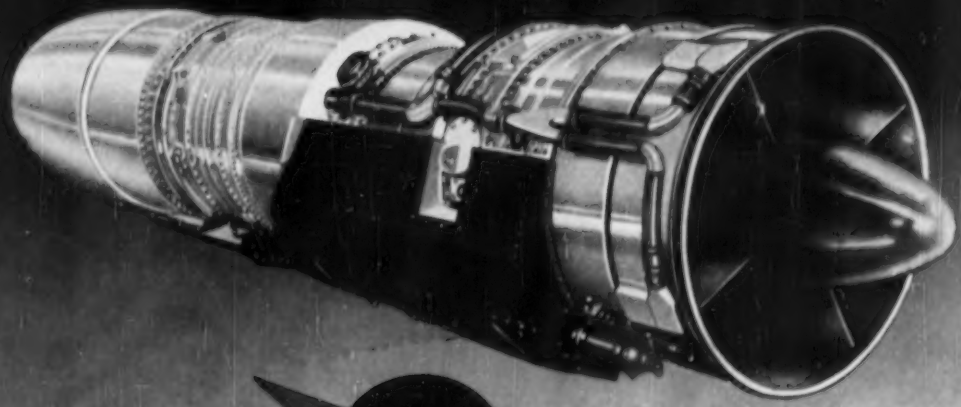
Shutdown Procedure

Shutdown was the reverse procedure; when the first chamber was cut off, the rocket powerplant automatically went through the complete shutdown cycle.

SEPR engines start life in the design offices and laboratories at Villejuif, a suburb of Paris. The installation is in the Redoute des Hautes Bruyères, one of the old forts built to defend Paris.

The first rocket engine test stands were located here, firing through the doorways of old storage vaults built

FLIGHT TESTING THE NEW IROQUOIS AT MALTON



For a well-defended future . . .
IROQUOIS,
Orenda's supersonic turbojet.

ORENDA *ENGINES LIMITED*

MALTON, CANADA

MEMBER: A. V. ROE CANADA LIMITED & THE HAWKER SIDDELEY GROUP

Now! A "Foot Thumper" gives a Pilot complete control over tire s-k-i-d-s!

At last—a pilot can be told in advance when an airplane tire is about to skid, *and he can prevent it from happening.*

It is a new, basic development in skid control. Engineered by Goodyear, it is called "Skid Warning."

A lifesaver and a plane-saver engineered for an era when aircraft land fast and are large and heavy, and whose pilots often are thirty feet or more ahead of the main landing gear. It keeps pilots informed by providing an extra safety signal of tire skids which he can neither see nor feel but which he must control.

In the lag between the time a wheel starts skidding and the pilot realizes what's happening—and can "ease up" on the "heavy" brake—the scrubbing tire can burn through its tread, all its many plies, and blow out in a matter of seconds.

In an even shorter time, the tire can "flat spot" and thereby be doomed to the scrap pile at a loss of hundreds of dollars.

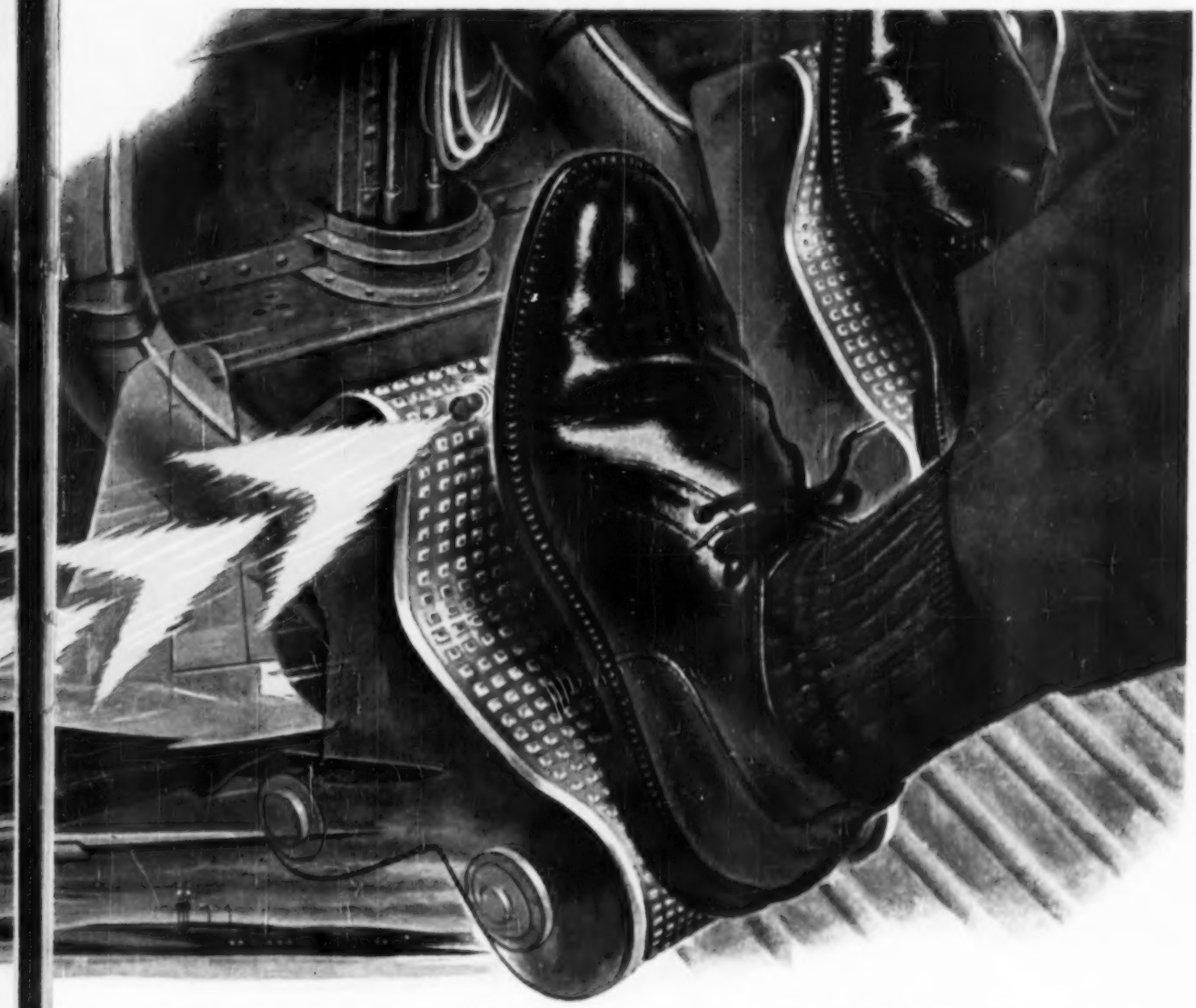
REVOLUTIONARY NEW SYSTEM

But now engineering by the Aviation Products Division of Goodyear has come up with the answer in its revolutionary Skid Warning System.* It actually senses a skid before it occurs—*transmits a signal directly to the pilot's foot on the brake pedal that is causing the trouble.*

TAPS PILOT'S FOOT

The moment rotation of any wheel begins to drop at an abnormal rate, a tiny sensing device on the wheel hub

GOODYEAR



actuates a small pulsating button mounted on the brake pedal. The pulsator literally "taps" the pilot's foot and tells him to "ease up" his brake pressure!

GIVES PILOT FULL CONTROL

This is the *first* system in which the pilot maintains full control—and full "feel"—of his braking at all times while having complete knowledge of what is going on in this heretofore "blind area of trouble."

Result? There is no veering. Flat-spotting of tires and wheel-locking caused by pilot inadvertently overbraking is virtually eliminated, aircraft "down time" is avoided. Maximum safe braking can be applied and landing runs substantially decreased.

BEST FEATURE: SIMPLICITY

Standout feature of the Goodyear Skid Warning System is the fact that no brake modification is required. It can be easily installed on any type brake or brake system, in no way disturbs the existing brake system — and can quickly receive C.A.A. approval.

ALSO COMPLETELY AUTOMATIC ANTI-SKID

In addition to Skid Warning, Goodyear also offers a *completely automatic Anti-Skid System* for applications where mechanized control of brake pressure is desired.

For complete information on either of these revolutionary new Goodyear Skid-Stopping Safety Systems, write: Goodyear, Aviation Products Division, Dept. H-1715, Akron 16, Ohio.

AVIATION PRODUCTS

More Aircraft Land On Goodyear Tires, Wheels and Brakes Than On Any Other Kind

CANADAIR "ARGUS"

Protecting the power of a hundred-eyed giant . . .

AUTO-LITE 350 HIGH-TEMPERATURE WIRE

Canadair's huge submarine hunter-killer "Argus" is an electrical giant with an automatic paralleling 400-cycle AC electrical system having a capacity of 160 KVA. More than 5000 separate wire installations use almost 60 miles of wire. In many critical applications where extreme physical and chemical demands are found, the Argus uses Auto-Lite 350 General Purpose High-Temperature Aircraft Wire.

Like many other airframe manufacturers, Canadair finds that the extra temperature range performance of Auto-Lite 350 Wire makes it superior in installations where extremes of heat and cold are a problem. Many manufacturers find that in addition to its high resistance to abrasion, flame, solvents, fuels, and lubricants, Auto-Lite 350 Wire reduces production costs, too, compared with other high-temperature wires.

- **Flexible at temperatures below —80° F.**
- **Smokeless**
- **Resistant to modern aircraft hydraulic fluids, lubricants, and fuels for both reciprocating and jet-type engines**
- **No discoloration at maximum operating cable temperatures**
- **Flame-resistant**
- **Easy printing of circuits with conventional marking machines**
- **Meets Spec. MIL-W-8777, U.S.A.F.**
- **Free stripping**
- **Manufactured in sizes 22 thru 2/0**

For complete information on Auto-Lite Aircraft Wire, including specifications and samples, write to . . .
The Electric Auto-Lite Company, Wire and Cable Division, Port Huron, Michigan or Hazleton, Pennsylvania

AUTO-LITE® 350 GENERAL PURPOSE HIGH-TEMPERATURE AIRCRAFT WIRE

under the gunnery platforms. No large-thrust rockets were tested here, but even so the proximity of apartments and houses has forced SEPR to shut down this facility as far as test firings go.

Probably the last run was made during this visit to Villejuif.

Component test work continues here; there are test stands for pump turbopumps, turbines, electrical and electronic work, ignition tests, cold chambers and a "plexiglas" rocket stand where the flame formation can be studied for a brief instant in the transparent chamber of a plastic rocket.

SEPR's main test facility is at Melun-Villaroche, major flight and experimental station near Paris used by engine and airframe manufacturers alike. Only liquid-propellant rocket work is done here. The availability of aircraft in nearby hangars makes the task of SEPR and airframe technicians easier in the matching of the rocket engines to the airplanes.

There are a total of about 20 test stands at Melun, all arranged for horizontal firing. Some of them have been designed so that the engines can be tested in a variety of attitudes from horizontal to vertical and inverted to check the system functions at expected flight attitudes. There is an altitude chamber at Melun that permits firings of rocket engines under simulated altitude conditions.

Solid Rockets

About 10% of SEPR activity is built around the solid-propellant rocket used both as a booster and as a sustainer.

First studies along this line began in 1951, several years after the liquid-propellant work was well underway. First unit was tested on the stand in 1952 and the first flight test of a solid SEPR rocket took place the following year.

Current line of booster rockets runs between impulse of 5,000 lb. sec. and 250,000 lb. sec.

Biggest of these is the SEPR 732 with a thrust of 44,000 lb. and a duration of 4.5 sec.

Designs and other studies of the solid-propellant rockets are done at Villejuif. Fabrication of the cases is done at the Argenteuil factory and loading and testing is done at Istres.

Powder used in the rockets is supplied by the French government, which retains a monopoly on all powder production, development and production.

Chemical Developments

Any rocket firm using concentrated acid as an oxidizer is faced from the start with some unusual problems of corrosion of the engine and its components. SEPR was no exception, and early in the game, began chemical research to develop some kind of an in-

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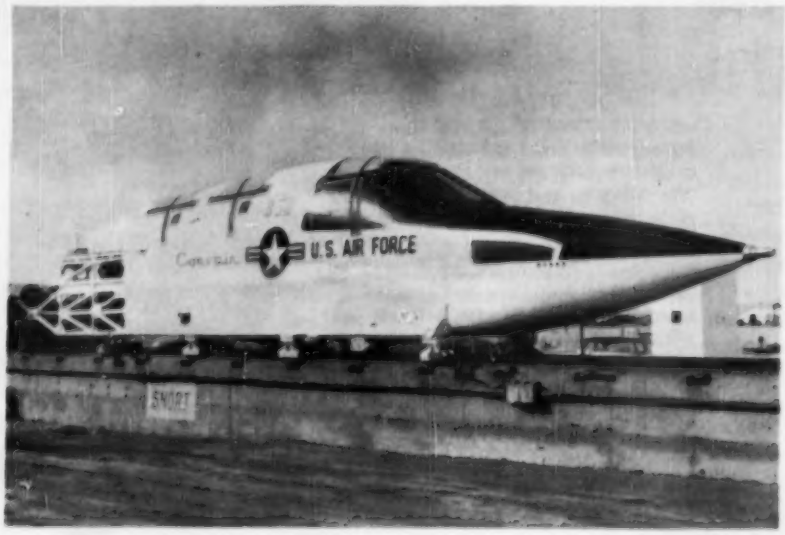
B-58 Supersonic Ejection Tested

Nose section of Convair B-58 Hustler bomber tests supersonic ejection of three-man crew using anthropomorphic dummies. Rocket powered sled develops more than 300,000 lb. thrust to propel the section down the 4.1 mi. track at the Supersonic Naval Ordnance Research Track, China Lake, Calif., the only track in the country long enough to handle the tests. Seat, fired by 4,500 lb. thrust rocket catapult, is thrown slightly forward to lessen deceleration shock. B-58 section is heaviest ever propelled down the track. Water trough (top) brings sled to safe stop.



hibitor to eliminate the extremely corrosive action of nitric acid.

The result of the research is a new phosphate derivative called Omnifos. Extended life tests have shown that this inhibitor protects steels and light alloys of copper and magnesium at room and elevated temperatures. One specific example is a pump rotor assembly which is an inert-arc weldment; one month in acid produced no weight reduction of the part.

Omnifos is added to the acid and is not a chemical treatment or coating for the material itself.

The company got its start through the initiative of one man, its present technical director Fernand Florio. A graduate of the Ecole Supérieure d'Aéronautique, Florio as a young officer in the Army was sent to Germany at the end of the war to study rocket development. Impressed with what he saw there, he came back and started work.

First of the SEPR rocket units were his personal work, and the early formative years were difficult as he and a few enthusiasts labored to produce operational and reliable rocket engines.

Within a decade the company has grown to a total of 950 employes working in a plant area of 124,000 sq. ft. in four locations.

Financial support for the development work comes from the French Air Ministry. Capital of the firm was supplied in large measure by three corporations: Société d'Electro-Chimie d'Electro-Metallurgie et des Aciéries Electriques d'Ugine, Sud Aviation and Air Liquide. First is the largest investor.

SBAC Lists Aircraft For Farnborough Show

London—Britain's P.1B supersonic fighter and possibly the SR. 53 mixed powerplant interceptor will be displayed at Farnborough air exhibition next month, the Society of British Aircraft Constructors said.

These aircraft also were on a list of the society's planned flying display:

The Wessex turbine powered helicopter; Accountant executive/feeder liner; H. D. M. 105 light transport; M. 100 Student jet trainer; Gannet V trainer; Canberra B.8; a Hunter fitted with a reverse-thrust device; a Britannia fitted with an Orion, a Proteus 755 and two 705s; an Olympus-Canberra, and the Scorpion-Canberra.

Also a Skeeter helicopter fitted with Napier tip-rocket boosters on its rotors to increase rate of climb or payload in temperate climates; Whirlwind; Widgeon; Sycamore; a twin engined Bristol 173 and Fairey ultra-light helicopters.

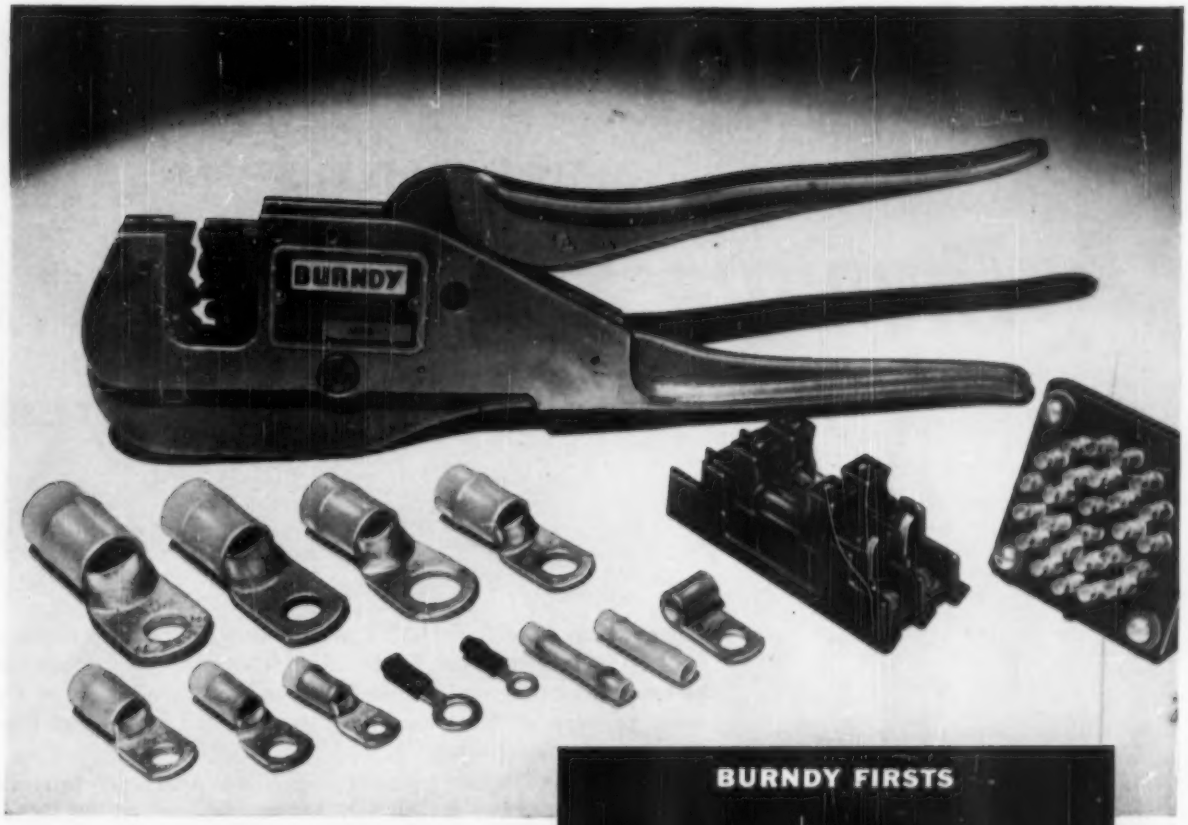
Also Comet III; Twin Pioneer, Herald and Pembroke transports; Jet Provost trainer; Gnat light fighter; Javelin Mk. 7 all weather fighter; T. 7 and Mk. 6 Hunters; Royal Navy's N. 113 Scimitar and DH 110 Sea Vixen; two V-bombers—the Victor and prototype Vulcan Mk. 2; the P.1A the FD 2.

New engine test beds to be shown include the Spectre-Canberra; Gyron Junior-Canberra and Conway-Vulcan.

Pachmayr Acquired by Airtek Dynamics, Inc.

Pachmayr Corp., manufacturer of aircraft components and supplier of heavy machined aircraft structures, has been acquired by Airtek Dynamics, Inc. Both companies are located at 2222 S. Figueroa St., Los Angeles.

Pachmayr will operate as a subsidiary of Airtek and is now modernizing its equipment, with emphasis on expanding its profile machining department and battery of Hydrotels.



FIRST

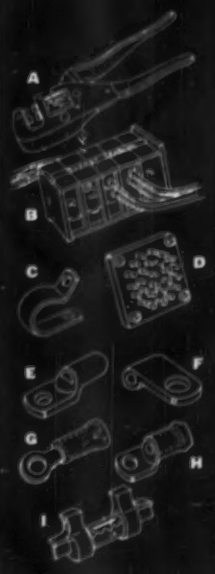
FOR MAXIMUM CIRCUIT SAFETY

YESTERDAY—Many of the most important technical improvements in aircraft electrical harness systems were originated by Burndy engineers working closely with the aircraft industry.

TODAY—Burndy terminals, current limiters and disconnect panels are specified for use in nearly every modern aircraft, military and commercial.

TOMORROW—Products now under development at Burndy will help make future planes still faster, lighter, safer.

BURNDY FIRSTS



A—Manual installation tools for all compression terminals. Bull. 53Y1.

B—Crablok multiple disconnect terminal strip. Bull. CB50.

C—Molded nylon cable hangers. Bull. HP.

D—Pressurized individual disconnect panels. Bull. 53F1.

E—Complete line of compression terminals thru 4/0. Bull. 51Y4.

F—Flag type compression terminals. Bull. 51Y4.

G—Insulated compression terminals thru 2/0. Bull. 53Y4.

H—Insulated aluminum compression terminals thru 1/0. Bull. 53Y4.

I—Limiters for circuit protection. Bull. 51F2.

Write for specific bulletin.

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NORWALK, CONNECT. FACTORIES: New York, California, Toronto **TORONTO, CANADA**
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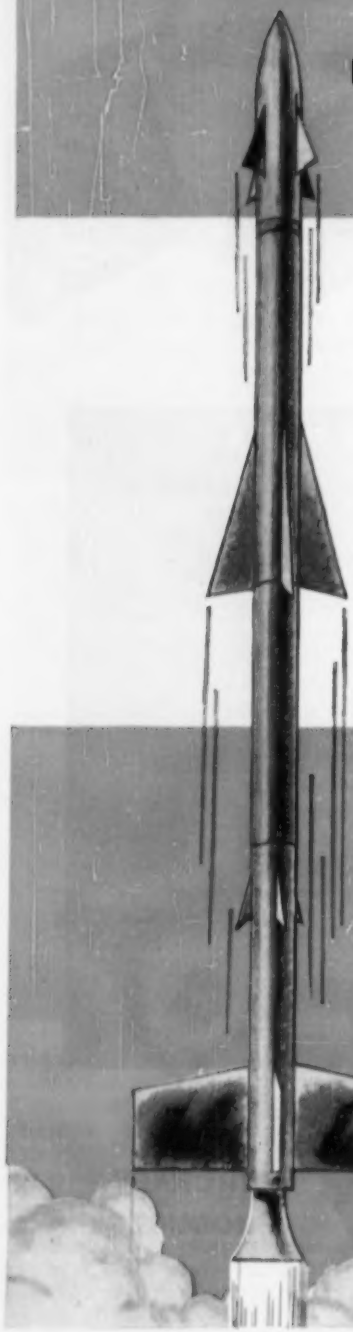


Tolerahces as close as ± 0.003″ can be achieved in the high-precision forgings produced at the Jet Division. These precise forgings can be made from titanium, stainless steel or high-strength alloys. For many applications, finish machining is eliminated, saving high labor costs and expensive scrap.

Make the Jet Division a part of your missile production program. By letting us produce forged and machined parts and weldments, you avoid the capital expense of your own facilities, eliminate the headaches of recruiting trained personnel, get your missile program under way faster.

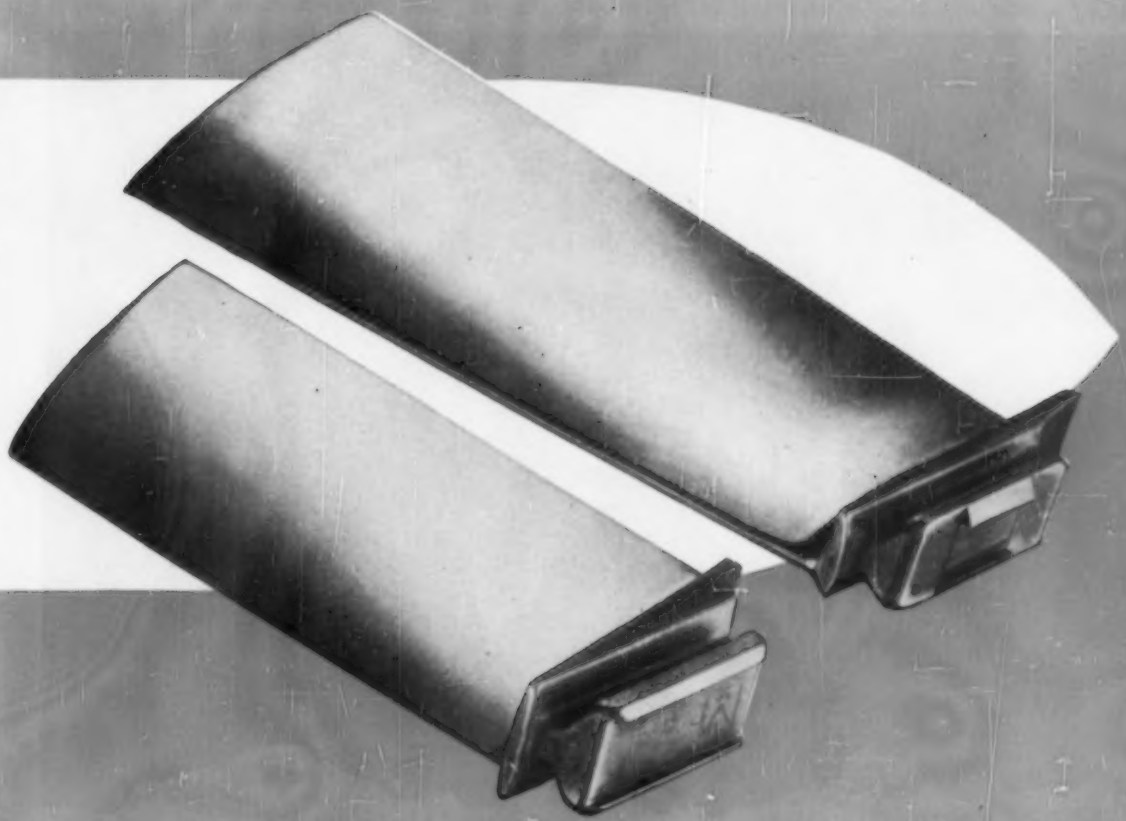
Our engineering and test facilities are also available to augment your missile plant. We can handle the complete job of producing missile air-frames, internal structures, and operating components.

WRITE TODAY FOR BOOKLET AW-267 which describes the engineering and production facilities of the Jet Division. A sales engineer will call at your convenience to discuss our abilities.

PROGRAM WITH

and High-Alloy Forgings

OF JET ENGINE PARTS

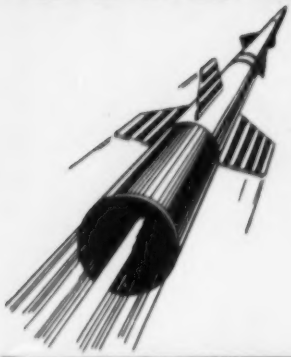


JET DIVISION

Thompson Products, Inc.

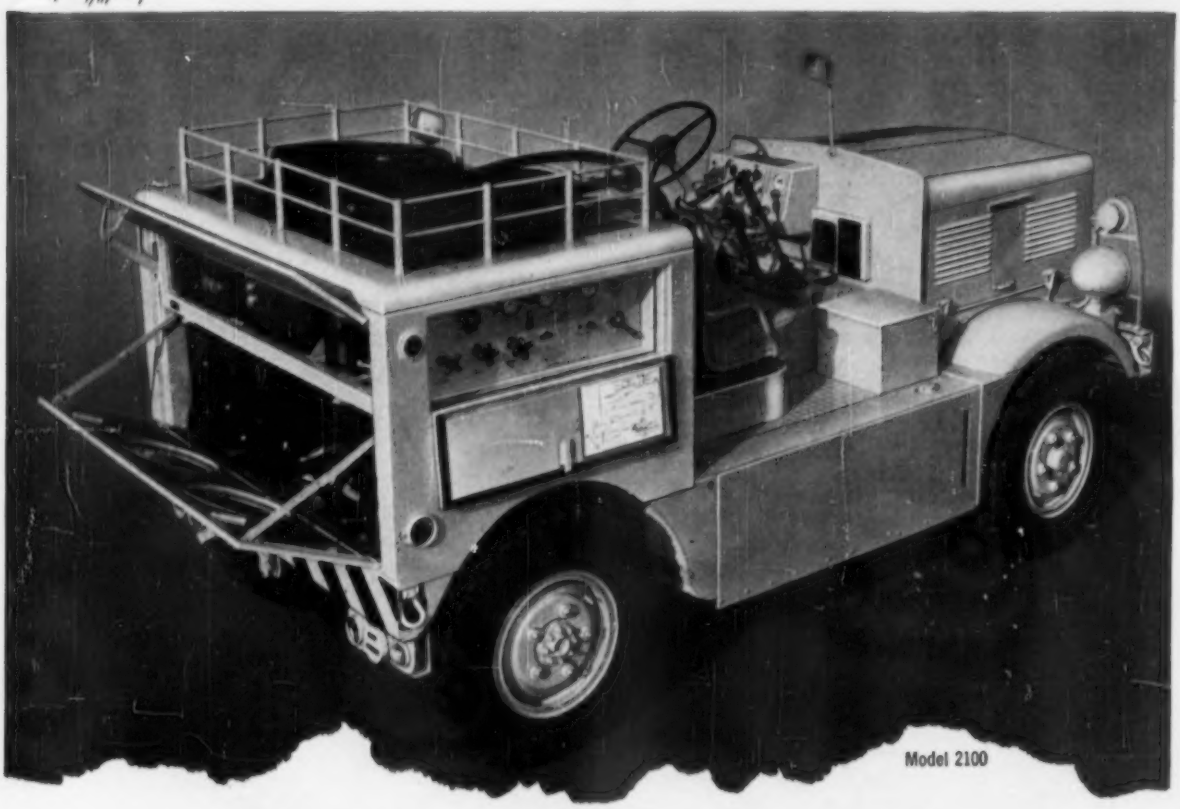
CLEVELAND 17, OHIO

THIS IS
GROUND SUPPORT!



The complex requirements of missile and piloted aircraft mean constantly stricter demands of ground support equipment. In this field, CONSOLIDATED has developed a wide range of single and multi-purpose units designed for both missiles and piloted aircraft. The compact Model 2100, for example, a self-propelled multi-purpose unit performs every function of electrical hydraulic and pneumatic testing . . is capable of servicing and starting guided missiles and jet air-craft quickly, surely and under the most difficult operational conditions . . . and can be used for heavy duty towing as well. It provides:

- **HYDRAULICS . . . 10 GPM, 3000 PSI variable volume, pressure compensating.**
- **TOWING . . . All wheel drive, over 6000 lb. drawbar pull.**
- **A. C. POWER . . . 30 KVA, 400 cycles, 3 phase and 10 KVA single phase, close regulated.**
- **D. C. POWER . . . 28.5 volts, 500 AMP continuous.**



Model 2100

OTHER MODELS OF SINGLE AND MULTI-PURPOSE GROUND SUPPORT EQUIPMENT ARE in active use with U. S. Air Force, Navy and Marine Units . . available with any combinations of . . AC and DC power . . high pressure air, hydraulics, and low pressure air . . refrigeration and heating.

CONSOLIDATED'S resourcefulness in solving the most challenging problems in the design and manufacture of ground support equipment attests to its ability to develop specialized units to fit your individual needs.

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MISSILE ENGINEERING

Guidance, Production Details Show Simplicity of Fireflash

By John Tunstall

London—Engineering and control details of Britain's first fully operational Mach 2 guided missile system—the Fireflash—were revealed last week during a tour of a pilot production line at Fairey Aviation Co.'s Weapons Division in Heston.

"In spite of presenting design problems 100 times more complicated than aircraft do," Development Chief L. R. E. Appleton said, "Fireflash went on to a production basis after only 3½ hours test flying."

Weapons System

The Fairey air-to-air missile brackets a radar beam laid on the target by a parent aircraft equipped with a simple permission-to-fire computer. Beam and gun sight are synchronized so that accuracy of the weapon depends solely on ability of the pilot to track the target with the image in the center of the sight graticule.

The weapon consists of an unmotored cruciformed winged dart boosted to Mach 2 by two solid fuel rockets. After separation, the dart coasts under directional control from four fins indexed at 45 deg. to the wing cruciform. During the boost phase, the missile is unguided and is spun with fins locked by offset venturis to counter thrust asymmetry. An explosive twin piston/cylinder breach block used to secure rockets ensures that the rockets react against each other during separation leaving the dart trajectory undisturbed. Rocket cases are finned to ensure safe dispersal.

Booster Separation

At separation (when combustion pressures drop to 250 psi.) the fins are unlocked and the missile becomes roll stabilized by control deflections about a datum established at launch. Finally when the roll error limits are established, beam guidance commands are switched into the control blocks. Relation of missile to beam is measured in polar coordinates, interpreted as Cartesian linear errors and resolved into roll and pitch planes.

These error signals are then fed to electro pneumatic valves serving the pneumatic actuator pistons to which the fins are cranked. All four fins are independently servoed and are not mechanically linked. During the initial gathering phase, clamping diodes restrict the maximum allowable lateral loading. Design loading for the missile is believed to be about 23G (component testing is taken up to 50G).

The missile divides into two major assemblies—the rear dart cylinder containing all power, control and guidance equipment, and the explosive assembly which comprises the two rockets, separation gear, warhead and fuse. Both assemblies are indexed together and are married by an internal ring nut and key.

Almost complete absence of machining in the weapon structure illustrates the insistence on simplicity, cheapness, ease of maintenance, interchangeability, and assembly. The dart body is basically an extruded magnesium-zirconium alloy cylinder 50 in. long, involves some upsetting and internal tapering forging operations at the wing root and at the forward marrying end but is machined only at the wing location platforms, and joint face.

All the wing and fin units are simply light alloy forgings machined only at bosses and wing platforms and all are interchangeable.

Rocket nozzles are straight carbon steel machined forgings.

Control and Guidance

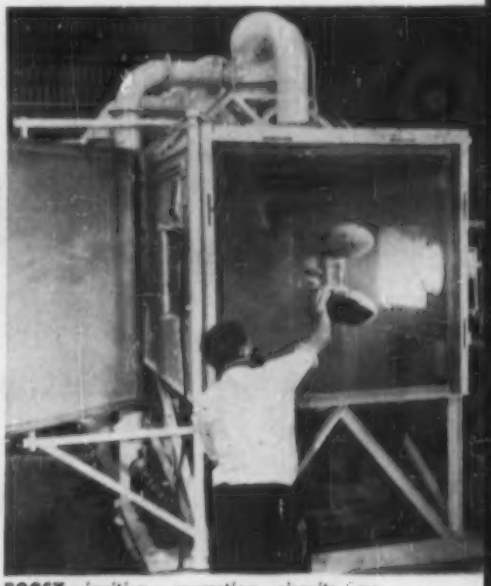
Two hollow extruded rails form a sliding unstressed chassis which locate the control and guidance mechanisms in the dart tube. They also act as hot air and wiring galleries.

In order from the fins forward are pneumatic actuator with four pairs of piston-cylinder units and four electro-pneumatic relay valves, capsulated electronic control and guidance elements and power supply, airblown gyro assembly comprising a roll displacement and two rate gyros, two lateral accelerometers, a 3,000 psi. air bomb with internal reducing valve (100 psi.). Aft of the fins is an aerial section.

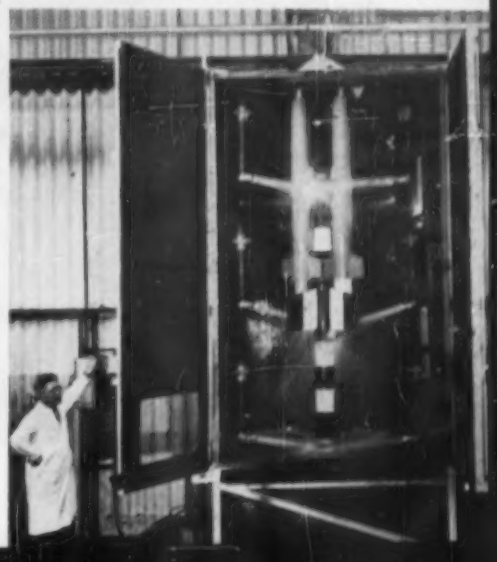
Points of special interest:

- **Forged light alloy** hemispherical air bottle encloses the reduction valve, saving considerable missile space without complicating valve design. The valve has considerable length but does not occupy much volume.
- **Two single action** pistons work a simple crank mechanism which oscillates the fins. Each pair is served by an electro-pneumatic reducing valve and the actuator consists of four such

LOW TEMPERATURE tests are carried out on Fireflash in Fairey's cold chamber. Ice has covered dart section of missile.



BOOST ignition, separation circuits are checked (top) after simulated dust and sand storm. Twelve shower heads (below) simulate effect of driving rain on exposed electrical components.



pairs, each independent. Valve and cylinder are the most precisely machined units in the weapon, being hand lapped together to limits of 0.000.1 in. The pistons have rubber rings underlaying teflon rings which have extremely low friction coefficient and are self lubricating.

Size Reduction

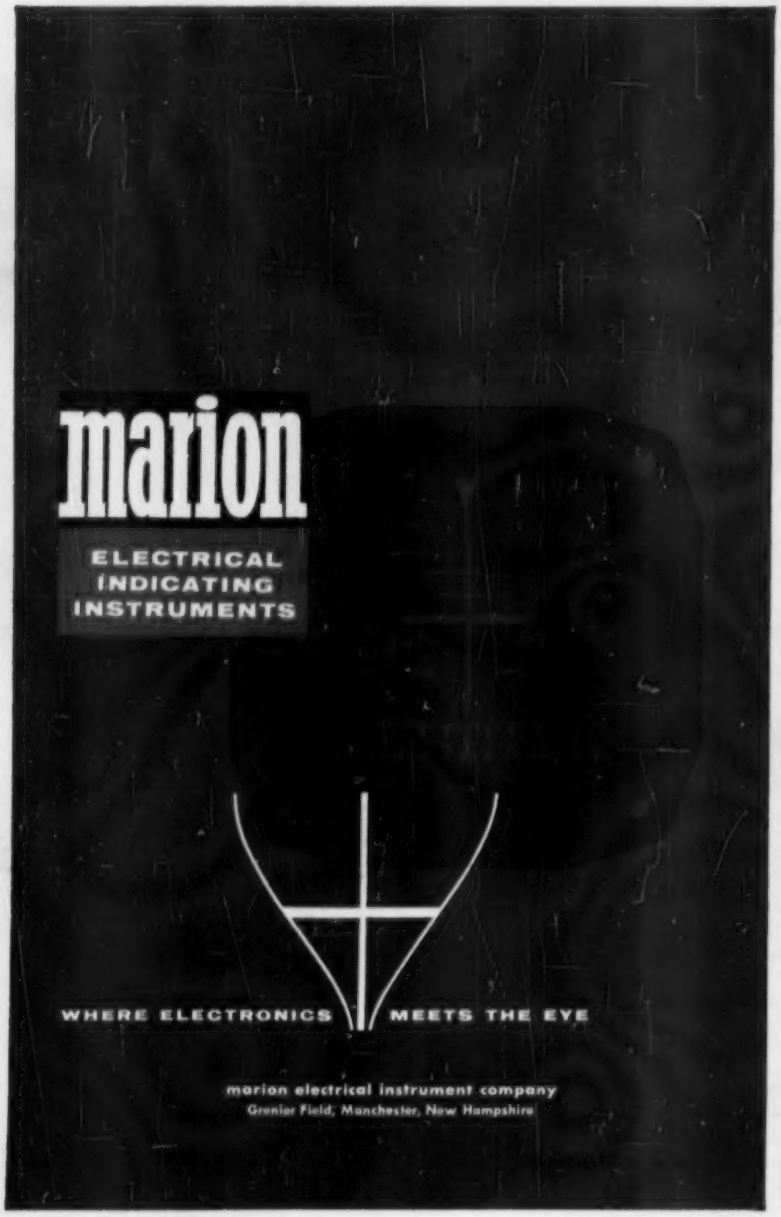
Their use has led to considerable air economies during the development period and resulted in bottle size reductions of over 50%. A pneumatic caging device ensures that the pistons are unlocked when the boosters separate. Air supplies to the gyros are provided from the aircraft's engine compressors and after launching the gyros coast. Fin position feed-back is transduced from carbon arc potentiometers swept by the fins.

• **Fairey's patented** X and Y rate gyros contain magnetic inserts which generate an a.c. signal in pick-off coils. Their output is attenuated by displacement of the gyros against a torsion spring restraint with fluid damping. Accelerometers are mass type supported from torsion springs fluid damped and sealed. Displacement is transduced from a wound potentiometer swept by the mass.

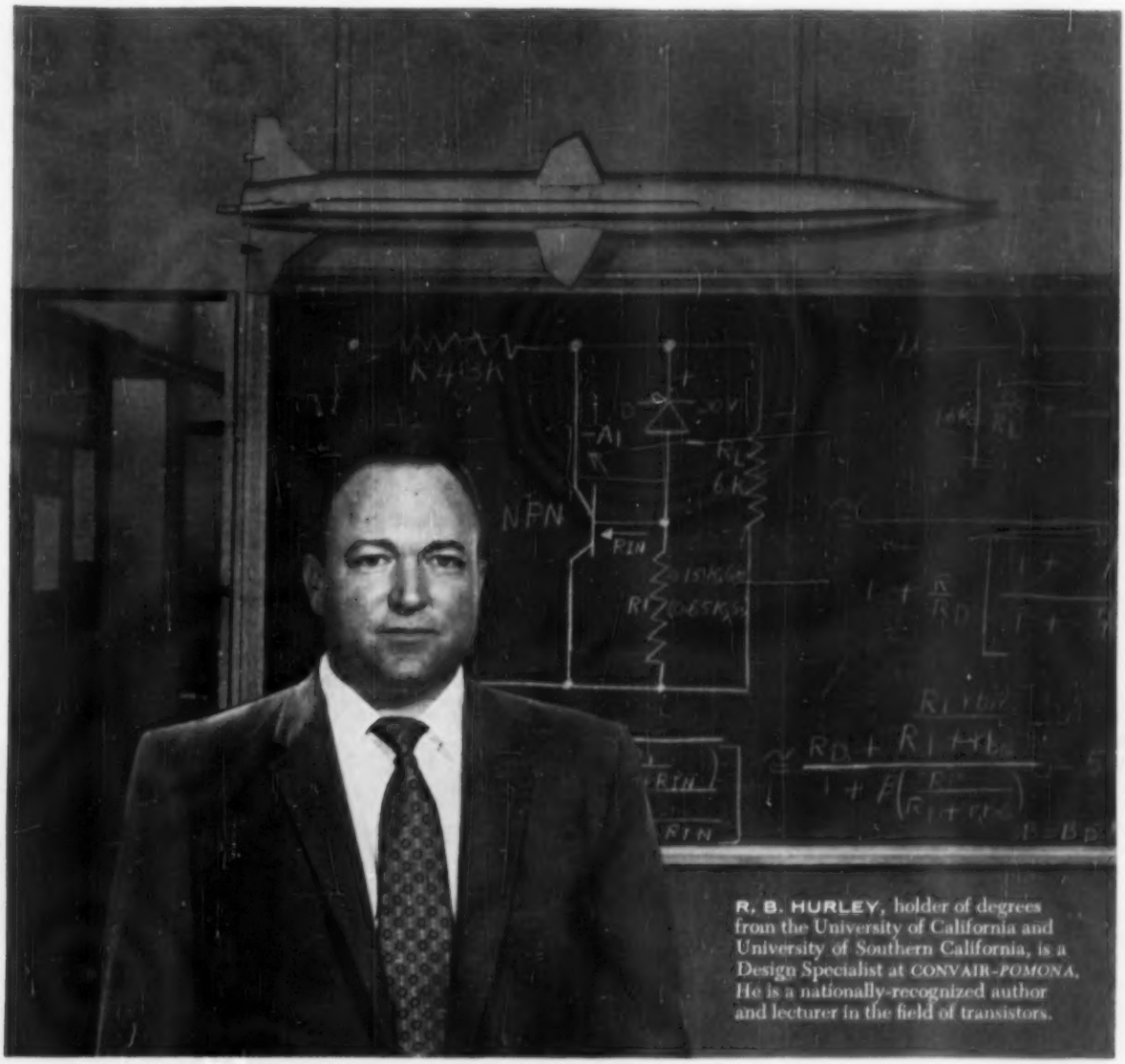
Roll displacement potentiometer is specially wound. An extremely simple and ingenious single friction cone and ring arrangement enables both roll gyro cages to be unlocked for testing.

The rate gyros have speed monitoring devices which compensate for deceleration of the gyro during the coasting period.

• **Circuits** are preformed and tested before marrying to the printed and capsulated elements. There are no transistors. Policy of the company has been to keep capsulated sizes down and have large numbers during the development period. Larger units are envisaged but, Appleton said, "When you have a missile working as well as this does you



INERT Fireflash knocking off target tail-wheel is photographed by high speed camera.



R. B. HURLEY, holder of degrees from the University of California and University of Southern California, is a Design Specialist at CONVAIR-*POMONA*. He is a nationally-recognized author and lecturer in the field of transistors.

"Engineers—here's how we're taking part in the electronics revolution toward solid state devices"

"Here at CONVAIR-*POMONA*, we are constantly studying ways to apply the new miniature solid state electronic devices: the diode, rectifier and transistor. So new is this semiconductor infant, and so vast its future – both for the military and industry – that our teams of electronics engineers actually 'go to school' under some of the foremost experts in the field.

"As the *first* fully-integrated missile plant in the U.S., CONVAIR-*POMONA* designs and builds the Navy's TERRIER supersonic missile. And, realizing the potential value of solid state devices in meeting the critical requirements of such airborne missiles, we initiated a 'transistor program' early in 1953. This program has multiplied many times to become one of the most important in the industry.

"You, as an engineer, can appreciate the tremendous expansion that will come in the application of solid state electronic devices in the next few years. And you can readily understand the advantages of studying and working with these devices, guided by the advanced thinking you will find at CONVAIR-*POMONA*.

"You'll like the atmosphere here, where you see and feel accomplishment. And you will enjoy living in Southern California's beautiful Pomona valley. For greater career opportunity – *for your future's sake* – send for more information about CONVAIR-*POMONA today!* Write to: Engineering Personnel, Dept. 3-F."

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World's Only

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The Army Aviation Center, Fort Rucker, Alabama, believes that its 1st Lieut. William Delos Smith is the world's only Finance Officer with wings.

This seeming paradox came about when Lieut. Smith, after earning an artillery commission in 1952 and qualifying as an Army Aviator, saw active service in Korea and then applied for a Regular Army Commission. Because of his civilian experience in a bank, his commission was issued in the Finance Corps.

That, however, did not deter Lieut. Smith's flying ambitions for he went on to qualify as a Rotary Wing Pilot. He is now a helicopter flight instructor at the Army Aviation Center, Fort Rucker, Alabama — one of the enthusiastic group of officers responsible for seeing that Army Aviation receives full value for the $60,000 estimated cost of training each Helicopter Pilot.

Helicopter flight and mechanical training are available to qualified personnel at the U. S. Army Aviation School, Fort Rucker, Alabama.

Watch "Whirlybirds" on TV — consult your local paper for time and station.

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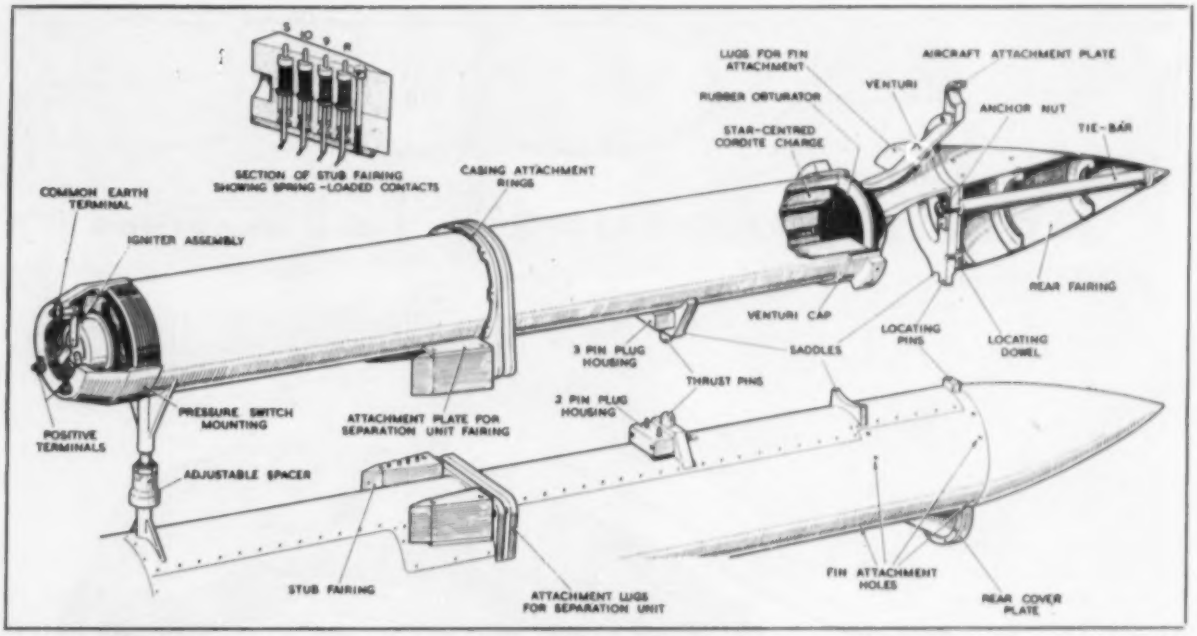


BOOST ROCKETS for Fireflash are shown in cutaway drawing. Solid propellant boosters separate when combustion pressures fall to 250 psi. and unmotored dart continues on to target. Missile is a beam rider.

don't rush in to change things all at once."

Testing Equipment

The company is enthusiastic about missile testing and calibration equipment which was completely integrated into the design and production planning from the outset.

At the factory a multiple battery of consoles provides facilities for the complete calibration of the whole missile power and guidance system with aerodynamic conditions simulated.

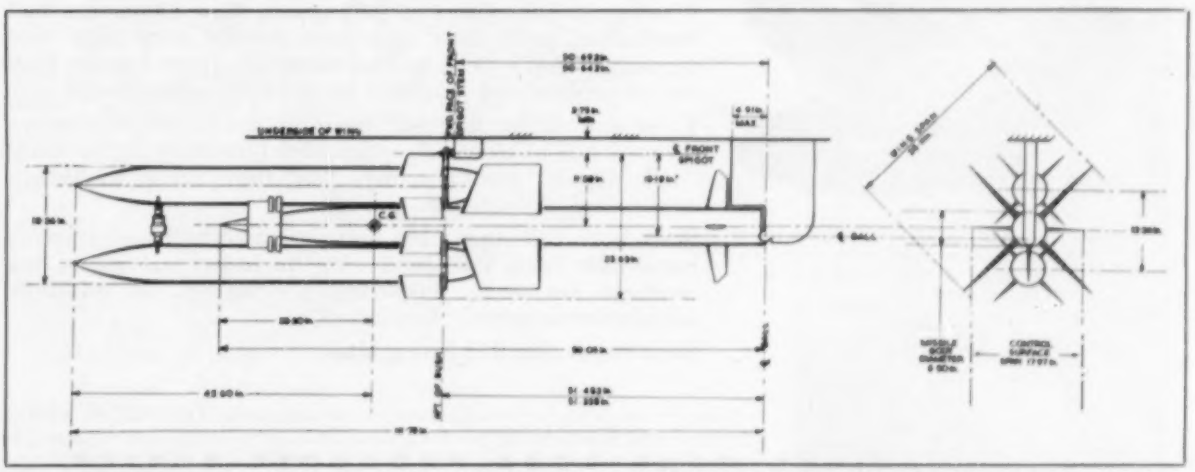
At all operational air fields a single console has been especially designed which repeats all the production tests on a go-no-go basis in 3½ min. Non-technical operatives can be familiarized with the console in under two hours. Right at the start weapon modifications were put in hand so that a practical console could be designed compatible with the test requirements, with minimum technical supervision.

The trolley on which the weapon is finally assembled before flight serves to transport the missile to the wing station and raise it into position.

Fuse and Countermeasures

Fairey claims the weapon is reasonably free from countermeasures on a basis of a time to switch and weight penalty imposed on enemy jamming aircraft. It is believed that the proximity fuse is not dependent on a fixed lethality distance but explodes when the missile reads the separation distance is approaching the minimum—hence the missile always explodes no matter how wide off the target. Tests have shown that an evading aircraft is a more vulnerable one because it presents a greater surface area.

To ensure component compatibility at the earliest possible moment under all conceivable environments and at any part of the world an extensive test laboratory has been available throughout the development history. Facilities include two 8 cu. ft. stratospheric chambers operating between −75C and +85 deg. 100% humidity and under



SIDE AND FRONT views of Fireflash give its main dimensions. After separation, control surfaces, indexed at 45 deg. to wing cruciform, guide weapon to target. During boost phase, missile is unguided and is spun with fins locked.

FACTS

about

NEW DEPARTURE BALL BEARINGS

New Departure split inner ring bearings are made in a range of sizes with and without inner ring puller grooves indicated in the exploded view above.

LOADS GET A LIFT with THIS BALL BEARING

Whether in helicopters or jet engines, New Departure ball bearings of split inner ring type provide very high load capacity. That's because the separable rings permit high race shoulders and a greater number of balls of large size.

These split inner ring *ball* bearings not only carry heavy thrust loads in either direction in addition to radial loads (with thrust predominant), but they have important application advantages.

Since both the inner rings and separator-ball assembly are removable from the outer ring as individual parts, the bearings are easily inspected or cleaned. In addition, installation is greatly facilitated.

Send for Folder TB listing sizes.

BALL BEARINGS MAKE GOOD PRODUCTS BETTER

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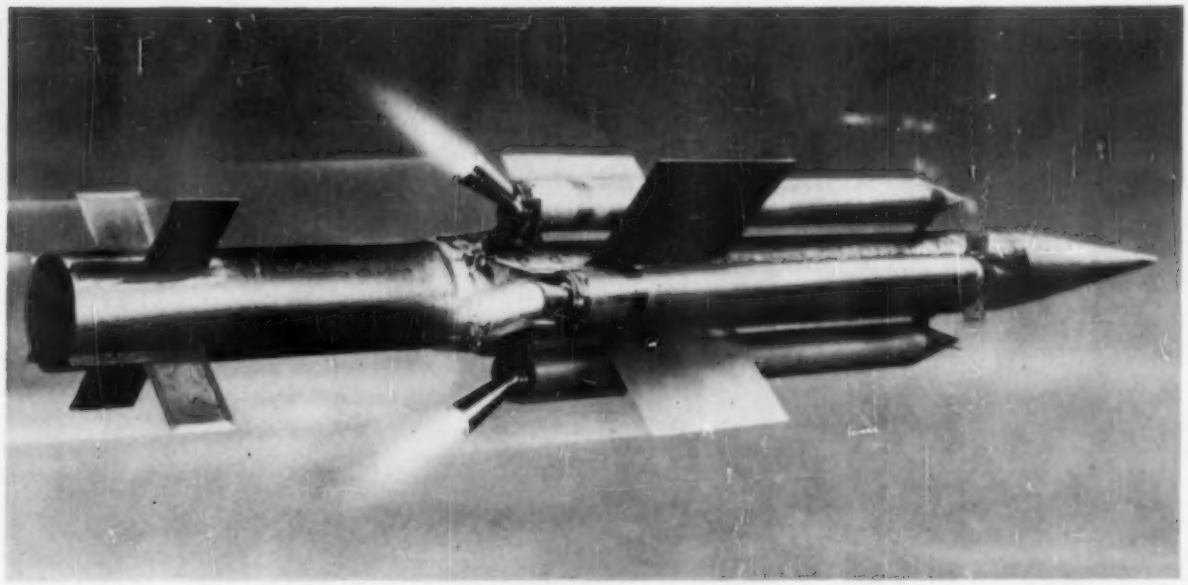
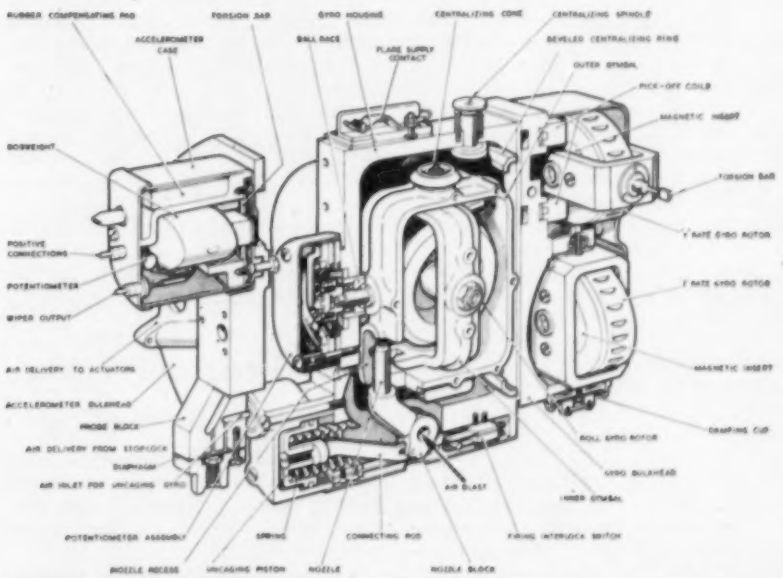


TEST VEHICLE (STV. 1) was one of fifty rounds fired to develop mechanisms to separate wrap around boost rockets from missile.

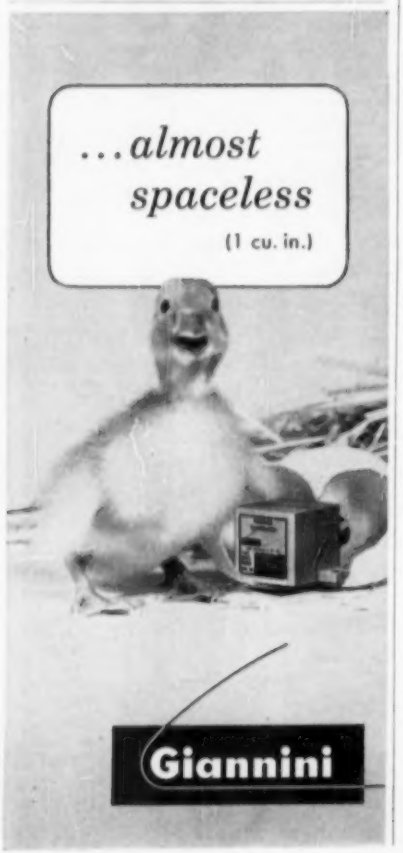
very high vacuum. A number of other similar chambers are unpressurized but simulate tropical life cycling conditions with associated fungus and bacteriological conditions, sand, dust and torrential rain. Other climatic facilities include ultra violet, acid, alkaline salt spray booths. Vibration equipment includes units up to five kw. output, a variety of vibration transducers, calibrators, impact testers centrifuges together with a conventional battery of structural test rigs.

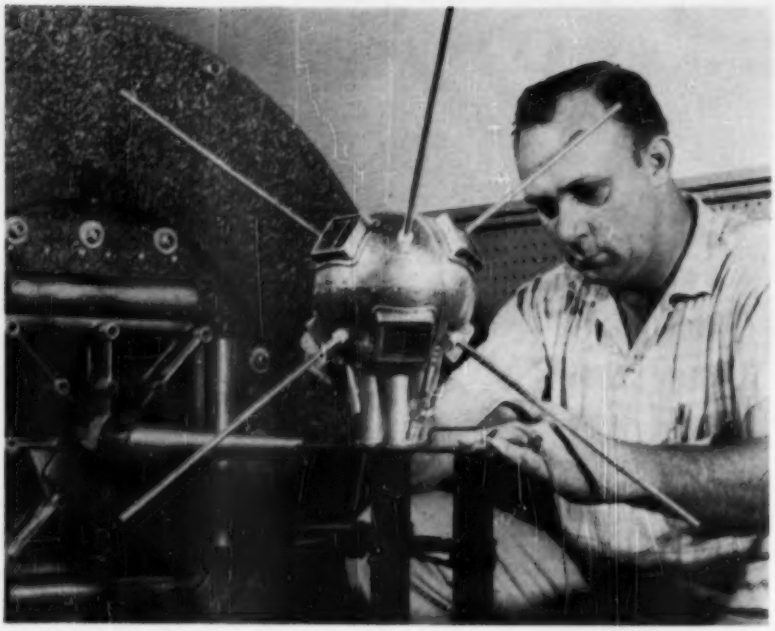
It was evident from certain components at the plant that the missile has passed through at least five prototype phases, which would seem to confirm the company's policy claim that the missile in each of its prototype phases could or was produced as a fully operational weapon.

Missile dimensions to nearest inch: Overall length 112; wing span 28; length of dart 89; rocket noses lead dart nose by 22; rockets 63; rocket centers 12.



CONTROL INSTRUMENT subassembly (above) comprises two rate gyros, one roll displacement gyro and a lateral accelerometer. One lateral accelerometer has been deleted for clarity. Separation of two boost rockets from unmotored dart (right) is tested with sandbags for protection. Explosive twin piston cylinder breach block used to secure rocket is fired to accomplish separation.





SIX INCH SPHERE similar to one that will be carried in a Vanguard test firing is prepared for vibration test. Six rectangular objects on surface house solar batteries.

Three-Stage Vanguard Vehicles To Carry Spheres in Test Firing

Washington—Next Vanguard test vehicle firing is expected in the near future. If it is successful, it will be followed by four test firings of complete three-stage rockets.

Test vehicle due for immediate firing, designated TV-2, consists of a prototype first stage of the final Martin Vanguard launching vehicle.

It includes General Electric Co. first stage engine and dummy second and third stages.

Defense Department has denied reports that an attempt would be made to launch a smaller satellite in the next set of four firings of complete Vanguard vehicles in order to orbit a sphere ahead of the Soviet Union, which also has a satellite program.

But it left open the possibility that the 6.4 in. magnesium spheres to be carried in the four three-stage test vehicles, or spheres carried in later test vehicles, might end up in an orbit.

Spheres planned for the next series of four test shots will carry antennas and Minitrack radio transmitters powered by solar batteries to permit tracking stations along the test range at Patrick AFB, Fla., to measure velocity both before and after the spheres are ejected.

Objective is engineering data on performance of the launching vehicle and the tracking equipment, Defense said—not an orbit. Fewer test instruments will be carried as test objectives are reached.

The decrease in payload weight will allow an increase in rocket velocity, "but is highly unlikely that an orbiting satellite will be achieved during the test phase of the project," Defense Department said.

Although the theoretical possibility of obtaining an orbit has existed throughout the planning of the test portion of the project, the department said, "it is only incidental to the objective of the test program, which is to develop a capability of launching a 20-in. instrumented scientific satellite during the International Geophysical Year."

Swift Program Again Criticized by British

London—Another government committee has blasted Britain's system of military aircraft procurement, this time concentrating on the Vickers Supermarine Swift.

The Committee of Public Accounts said expenditures on the Swift, amounting to about $112 million had been "largely abortive." This statement corroborated one earlier this year by a House of Commons Select Committee

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THE "ONE CUBIC INCH" PRESSURE TRANSDUCER —so small that 93 instruments won't quite cover this ad—packs king-sized performance in its 1"/side case.

Developed for the Vanguard Earth Satellite, this potentiometer output transducer provides a high level output proportional to absolute, differential or gage pressures to 50 psi. Resolution is better than 300 wires (0.33%) and weight is *less* than 3 oz.

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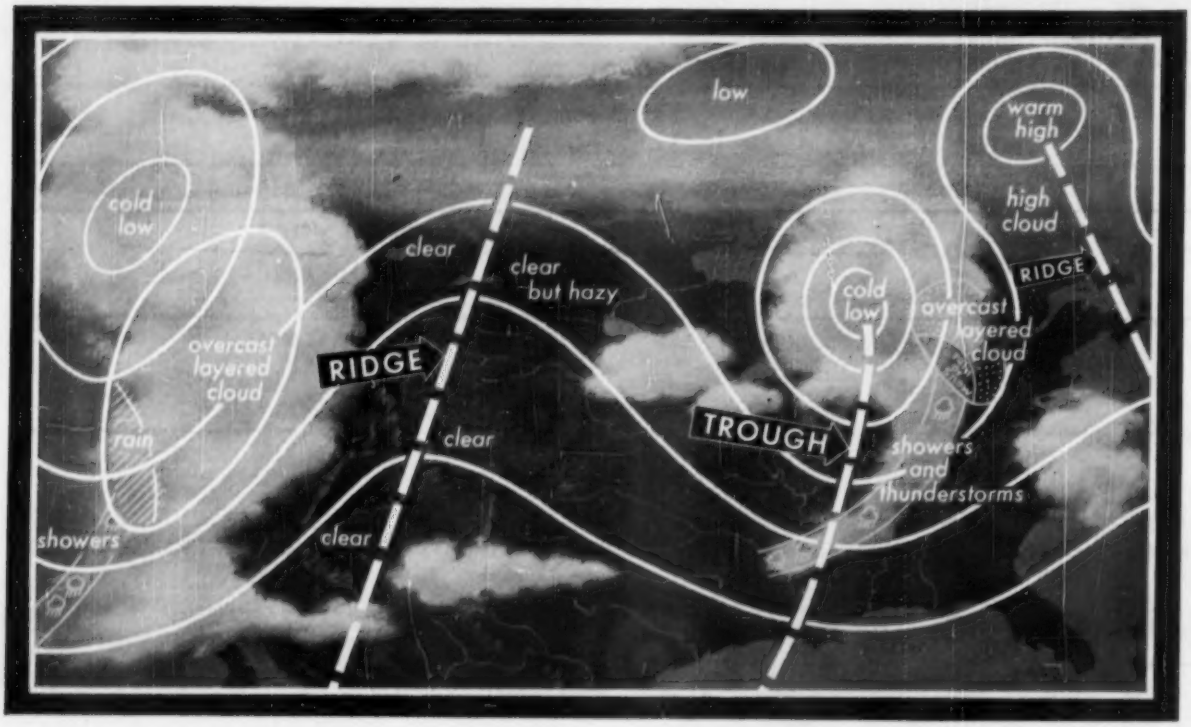
FLY WEATHER-WISE

These weather items prepared in consultation with the United States Weather Bureau



CIRCULATION PATTERNS

Clockwise circulation of air around High Pressure areas and counter-clockwise flow around Lows in the northern hemisphere are well known to most pilots. However, there are some lesser-known features of Highs and Lows which have become apparent with the progress made in upper air analysis.

Warm Highs—Extend to levels above 10,000 ft. with temperatures generally warmer than Standard Atmosphere. As this type of High extends farther aloft, it often assumes an elliptical shape with major axis lying N/S to form a *Ridge*. This Ridge normally moves very slowly, blocking eastward movement of weather systems at lower levels, often causing prolonged periods of fair or rainy weather in adjacent areas. Weather in warm Highs is usually dry, fair and often hazy.

Cold Lows—Extend to high levels with temperatures generally colder than Standard Atmosphere. Their normal eastward movement slows until sometimes the center aloft becomes stationary or even retrogrades westward. This is called a Cold Low because of concentration of cold temperatures near the center. V-shaped elongation of these Lows toward the south is referred to as a *Trough* and marks region of wind shift and possible clear air turbulence.

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For piston engines: Mobilgas Aircraft helps assure availability of full power from takeoff to landing.

For jet engines: Mobiljet fuels available for wide extremes in flight temperature conditions. Free flow assured under all conditions. Excellent thermal stability.

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SOCONY MOBIL OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORP., MOBIL OVERSEAS OIL CO., INC.

on Estimates (AW Jan. 28, p. 26).

"The expenditure of 40 million pounds sterling has been largely abortive in that it has produced no aircraft for the operational role which the Swift was originally intended to fulfill," reports the Committee of Public Accounts.

Even the fourth Swift model, the committee said, "could not be relied on at altitudes at which it was required to operate, and would not therefore be efficient in the interception role for which it had been intended."

The Swift was scheduled for operational service in 1953, but the first three versions were not considered safe for high altitude testing.

When the fourth model was delivered in 1954, it was tested at height and found to have "bad maneuverability." As a result, contracts for 492 Swift aircraft were cut in February, 1955, to 170 aircraft, excluding prototypes.

At that time, the Royal Air Force had 39 Swifts.

The committee said the Royal Aircraft Establishment had forecast in December, 1950, that design proposals for the Swift would lead to an aircraft with certain defects in performance and had suggested various corrective remedies.

Some of these changes were adopted, but they proved insufficient to correct the main defect that had been forecast, poor maneuverability at altitude.

Ministry of Supply was advised by the treasury solicitor that any claim for breach of contract had been irreparably damaged by acceptance of prototypes and a number of production aircraft.

The Committee says it "doubts" whether the government's financial and technical control over four years of Swift development "was close enough to ensure that work was curtailed as soon as possible."

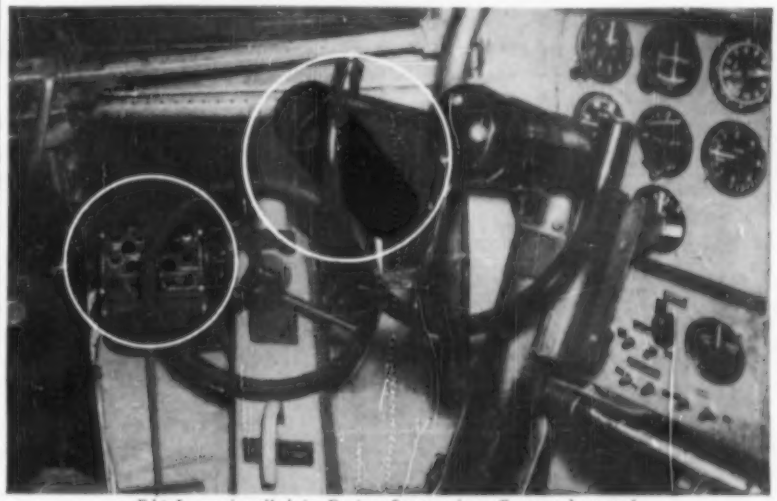
Stating that it is "dangerous and speculative to place production orders for a new type of aircraft on which full preliminary work has not been carried out," the committee recommended that in the future the government specify major requirements for aircraft in sufficient detail to "place on the contractor responsibility for meeting them."

The committee noted that the Air Ministry had complained about the amount of information given by the Ministry of Supply on the technical troubles that have been experienced with the Swift.

It recommended that the Air Ministry henceforth should have full access to all technical reports on progress and full information about steps proposed to bring aircraft up to the standard required.

Missile Hangar

Missile inspection hangar is under construction for Army ballistic missile program at Huntsville, Ala. This $2½ million building is one of seven projects on which the Army Ballistic Missile Agency says it is spending $15 million. Here missiles will be assembled and checked out prior to shipment. Another $2½ million worth of equipment will be used for the checkout. Among the other additions in the works at Huntsville is the re-housing of the computing units to plot in 5-10 minutes free-flight trajectories that would take 35-40 man-years with a desk calculator. ABMA explains that this building program is an attempt to "properly" house the ballistic missile development team which has been using inefficient made-over warehouses and factory buildings.



Edo Loran installed in Boeing Stratocruiser. Command control on left, display to right of nose steering wheel for pilot operation.

EDO LORAN

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Edo Airborne Loran has been shuttling back and forth across the Atlantic for the past six weeks giving completely satisfactory service, and precise navigation information. Pilot reports range from "Okay" to very high enthusiasm.

Edo, with its compact design and extreme low weight, puts Loran in the cockpit, gives the pilot directly-read line of position information as simple to use as any other pilot-operated radio navigation device.

Many major trans-oceanic carriers, convinced of Loran's time-proven accuracy and concerned by the complexity and weight of new proposed systems, have indicated that the lightweight Edo Loran admirably meets their long range navigation requirements. Edo Loran is already being designed into the instrument panels of the Boeing 707 and Douglas DC-8 jet transports.

COMPACT CONTROL unit measures 4⅛" high, 5¾" wide, 4⅛" deep for cockpit installation. Total weight is 29 pounds. For full information send for brochure.

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Systems engineers can now gain *simplicity and better performance in torque synchro systems* by using new synchros developed by Norden-Ketay for the Bureau of Ordnance. The unique design reduces error by approximately one-half while increasing torque 2 to 3 times in comparison with standard Mil synchros. By performing interchangeably as Torque Transmitters and Receivers, these synchros offer the further advantage of systems simplification. This new development by Norden-Ketay *extends the capabilities of the systems designer to advance beyond previous limits of performance.*

- *Higher Torque Gradient* —
  2 to 3 times previous mil spec values.
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  Size 15: ±6′ compared with ±12′ (Mil)
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- *Multi-function Versatility* —
  Torque and Accuracy values excel Mil torque transmitters and receivers. These synchros can be used interchangeably in both functions with improved system performance.
- *Greater Dynamic Accuracy* —
  Higher torque provides receiver error of ± 1.0° max. throughout the life of the unit.

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FUNCTION	UNITS	NEW MULTI-FUNCTION SYNCHROS	STANDARD MIL SYNCHRO	NEW MULTI-FUNCTION SYNCHROS	STANDARD MIL SYNCHRO
NORDEN-KETAY TYPE		105C2E1	105C2A3	108C2C2	108C2B1
SIZE		15	15	18	18
Number of Phases { STATOR / ROTOR		3 / 1	3 / 1	3 / 1	3 / 1
EXCITATION PHASE		Rotor	Rotor	Rotor	Rotor
FREQUENCY	cps	400*	400	400*	400
VOLTAGE RATING	volts	115/90	115/90	115/90	115/90
Maximum Input { CURRENT / POWER	amps / watts	0.20 / 3.0	0.176 / 3.1	0.50 / 5.5	0.275 / 4.1
INPUT IMPEDANCE	ohms	680/83°	715/81°	235/84°	460/83°
FRICTION TORQUE AT 20°C MAX.	oz. in.	0.05	—	0.05	—
ELECTRICAL ERROR, MAXIMUM	minutes	±6	±12	±5	±8
RECEIVER ERROR, MAXIMUM	degrees	±1.0	±1.0	±1.0	±1.0
TORQUE GRADIENT, MINIMUM	oz-in/deg	0.026	0.013	0.10	0.036
DAMPING TIME, MAX. (179°)	seconds	2.0	2.5	2.0	2.0
OPERATING TEMP. RANGE	°C	−55° to +55°C (Available on special order to 125°C and 200°C)			
WEIGHT	oz.	7.2	6.4	10.0	9.0
MIL DESIGNATION		15TR4b	15TR4a	18TR4b	18TR4a

*Although these synchros are rated at 400 cps, they are available to your order to operate at any frequency from 400 cps to 10,000 cps.
Data at extremes of temperature available upon request.

How the Maser Operates: Part II

Maser's Potential Rests on Further Work

By Dr. Richard W. Damon

Increasing pace of research in atomic amplifiers, spurred by their potentialities for improving radar, communications and countermeasures equipment performance, has already produced a variety of techniques and experimental devices.

The earliest versions were called Masers, because they operated on the principle of Microwave Amplification by Stimulated Emission of Radiation. Although more recent devices operate on slightly different principles, the term Maser is sometimes applied, although perhaps atomic amplifier is a better generic term.

Low Noise Level

All of the devices and techniques share a common advantage: extremely low noise level compared with existing microwave tubes. Although earliest Masers used a gaseous medium, present emphasis is on solid state materials. Solid-state atomic amplifiers differ both in the structures of materials employed and the technique used to supply energy to the device for subsequent extraction as an amplified signal.

The two-level, or pulsed, Maser is a solid-state device that uses a paramagnetic salt such as cerium ethyl sulfate or copper Tutton salt. The name is derived from the fact that its operation is based on the use of two energy states of the spinning electrons, which behave like tiny gyros with a magnet attached. This explains why the two-level Maser is sometimes called a gyrotron or versitron.

The paramagnetic crystal is placed in a resonant cavity or similar microwave structure and exposed to the incoming microwave signal to be amplified. This signal produces a pulsating magnetic field that reacts with the gyro-magnets. In addition a d.c. magnetic field is applied at right angles to the pulsating (signal) field, its strength selected to make the gyro-magnets in the crystal resonant at the frequency of the incoming signal.

Crystal Inversion

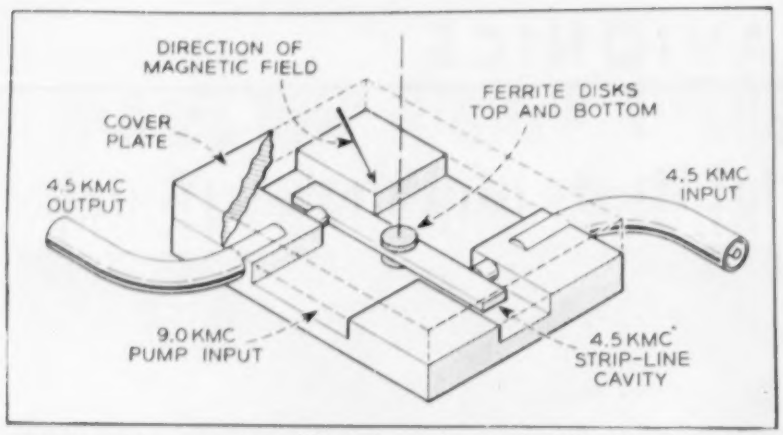
To obtain amplification, the crystal's gyro-magnets must first be inverted to increase their internal energy. One way to accomplish this would be suddenly to reverse the polarity of the steady magnetic field. The gyro-magnets would then seek to align themselves with the new field polarity, requiring a 180-degree shift of spin axis. The time required for this realignment is called the spin lattice relaxation time.

During approximately half of this relaxation interval, the gyro-magnet gives up energy to the pulsating microwave field, producing amplification of the signal. (Gyro-magnet dissipates energy exponentially with time, much like a capacitor discharging through a resistance.) During the last half (approximately) of the return-to-equilibrium cycle, the gyro-magnet produces no signal amplification but instead absorbs energy from the input signal. When the gyro-magnets have reached equilibrium position, the steady magnetic field can be reversed again to repeat the operating cycle.

One of the limitations of the two-level Masers is that gain can be obtained for only a part of the total operating cycle and increased gain is obtained at the expense of lower Maser duty cycle. Possibly this limitation can be circumvented with new materials or techniques which permit relaxation times to be shortened following the useful amplification portion of the cycle, but considerable work remains to be done before this can be achieved.

Reversal of large magnetic fields at

FORWARD SCATTER communications will be one of the first applications of the extremely low noise characteristic of atomic amplifiers.



ONE TYPE of ferromagnetic amplifier is shown schematically (left). Size of the device can be seen from picture at right. Amplifier pictured was developed at Bell Telephone Laboratories.

extremely high rates is rather expensive in terms of power and there are more attractive ways of achieving the same effect. One, for example, called adiabatic fast passage, introduces a second source of microwave energy into the same waveguide carrying the microwave signal to be amplified. This second source produces a strong radio frequency field on the crystal and provides energy required for amplification.

If the frequency of this second source is rapidly varied from slightly above to slightly below the frequency of the signal to be amplified, the effect on the gyro-magnets is essentially the same as reversing the polarity of the d.c. magnetic field and therefore produces the desired spin inversions. In a typical application, a second source of a few watts is swept through a change of about 10 mc. in several microseconds. This is easier and more economical than reversing the d.c. field.

180 Deg. Pulse

Another spin inversion technique, called the 180 deg. pulse method, also employs a second source of microwave energy. Instead of varying (sweeping) the frequency of this second source, it is applied for a time equal to approximately one-half the spin inversion period, the latter depending upon the radio frequency power level of the second source. Typical values are about 100 watts RF power applied for a few microseconds.

Disadvantage of this technique is that Maser gain and efficiency suffer unless the product of radio frequency field strength and pulse duration are precisely maintained. The two techniques require about the same amount of RF power, but the adiabatic fast passage method allows much greater tolerances on field strength and frequency of the second source. For some applications the 180 deg. pulse technique may be useful.

Operating properties of the two-level Maser in pulsed-circuit applications can be predicted quite accurately from known properties of the paramagnetic material used. Following are some of the significant operating characteristics:

• **Operating frequency ranges** from 100 mc. to about 100,000 mc., tunable by changing strength of steady magnetic field.

• **Relaxation time,** which determines maximum pulse rate, ranges from fraction of a microsecond to a minute or more, depending upon material used and its temperature. Materials with long relaxation times usually have low paramagnetic ion concentrations and hence are severely limited in power output. Materials with relaxation times in milliseconds to fractions of a second are quite suitable.

• **Gains of 10 db.,** with bandwidths of 10 mc., or 20 db. with 1 mc. bandwidth appear feasible with known materials when operated at liquid helium temperatures. Gain-bandwidth product is essentially constant. However, gain decreases rapidly with higher temperatures and operation at room temperature appears unlikely.

• **Noise figure** for two level paramagnetic Maser operated at room temperature is about 3db., compared to 6 db. for conventional microwave amplifier. But when cooled to temperature of 77K (liquid nitrogen), noise figure is only 1.1 db., and it is only 0.06 db. at 4K (liquid helium).

The foregoing noise figures assume that the Maser is shielded from thermal radiation emitted by other circuit elements through use of a non-reciprocal device such as a circulator or gyrator.

Ultimate lower limit of Maser noise figure is set by spontaneous emission of radiation that occurs as gyro-magnets return to equilibrium. For example, at an operating frequency of 10,000 mc., spontaneous emission produces a noise figure of 0.007 db. which can not be eliminated even if the Maser were cooled down to a temperature of absolute zero.

For continuous-wave (CW) operation, another type of device, called the three-level Maser, is under investigation. It is more restricted in the type of paramagnetic materials which can be used and its mode of operation differs from the two-level device described previously. (The CW Maser can be gated for pulse operation also if so desired.)

The properties of the three-level Maser resemble those of the two-level device except that the undesirable low duty cycle for amplification is eliminated and some increase in gain can be achieved with suitable materials.

Three Level Maser

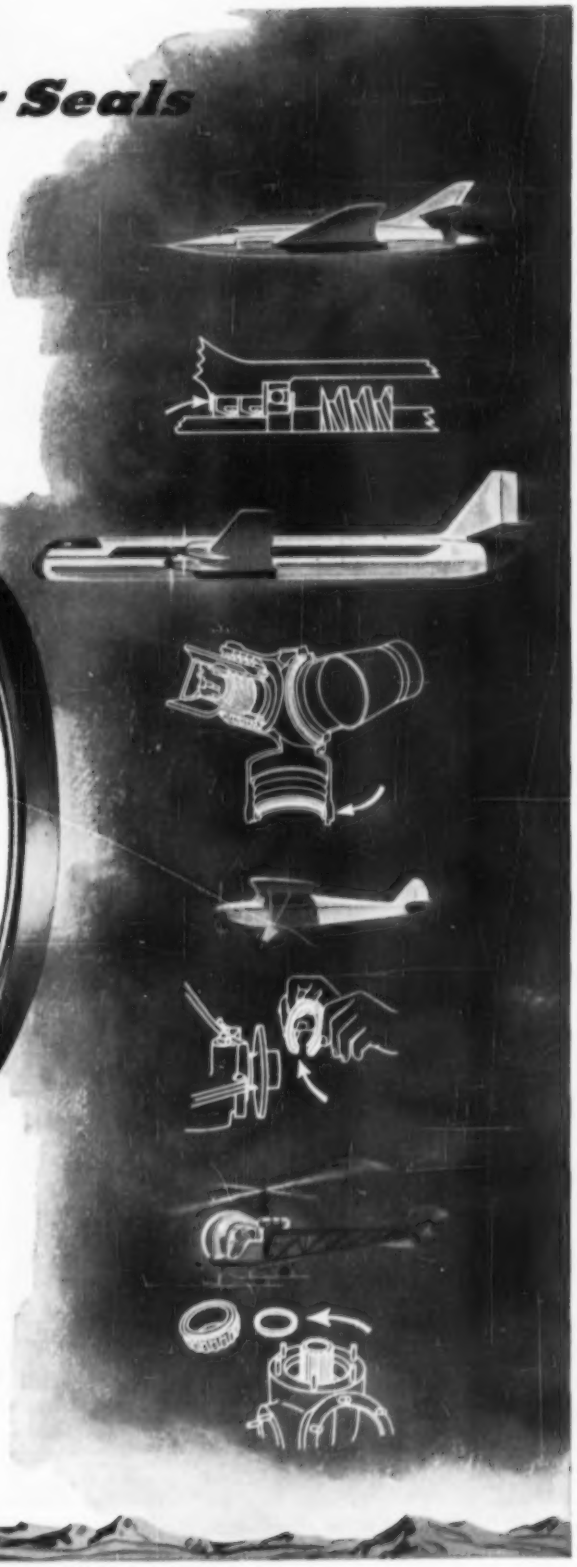
Using the previous mechanical analogy, the three-level Maser operation can be explained on the basis of two inter-coupled gyro-magnets instead of the one involved in two-level Maser operation. Supplementary microwave energy is continuously fed into one of the two coupled gyro-magnets. This energy is internally transferred to the second gyro-magnet in such a way as to continuously maintain it in the inverted state so that it has energy available for amplification.

The supplementary microwave energy, supplied by an auxiliary oscillator, is comparable to that used in the adiabatic fast passage and 180 deg. pulse techniques, but is supplied continuously in this case.

The choice of materials for use in a three-level Maser is not as wide as for the two-level device, but a variety of suitable paramagnetic salts are known. Operable Masers of this type have been constructed using diluted crystals of hydrated gadolinium ethyl sulfate and similar crystals of potassium chromecyanide, operating at liquid helium temperatures.

Many investigations of three-level

The skies are full of J-M Clipper Seals



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In Bearing Mechanisms—High sealability and low friction at high shaft speeds make Clipper Seals particularly suitable for clutch and transmission bearing mechanisms in helicopter rotors.

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Johns-Manville CLIPPER SEALS

RUGGED OPERATOR—Unloading a jeep in rough terrain, this Marine Corps Sikorsky S-56 shows its usefulness under field conditions during Fleet Introduction flights at Quantico. The Marine Corps has organized its first S-56 squadron, HMR (M)-461, at New River, N. C. The big, twin-engined S-56, which can carry 26 men and their gear, is flown as the HR2S-1 by the Marine Corps and as the H-37 by the Army.

AROUND THE WORLD WITH SIKORSKY HELICOPTERS

THE OLD AND THE NEW—One of the last of the Army's mules and its rider from the 35th QM Co. (Pack) meets a Sikorsky S-58 (Army H-34) bringing in rations during maneuvers near Camp Hale, Colo. The Army has announced deactivation of mule-equipped units and the creation of new helicopter companies.

MATERNITY MISSION—Racing the stork, a U. S. Air Force Sikorsky H-19 based at Prestwick, Scotland, flew a critically ill expectant mother from the isolated Isle of Arran across the Firth of Clyde to a hospital normally eight hours away by boat. The mother recovered; the baby girl weighed 8½ pounds.

TO DOWNTOWN CHICAGO—Sikorsky helicopters flown by Chicago Helicopter Airways are now operating on convenient, frequent schedules connecting Midway Airport, O'Hare International Airport, and Meigs Field, adjacent to the Chicago Loop. New 12-passenger Sikorsky S-58s are joining the fleet of S-55s already in service in Chicago. Sikorsky helicopters are also standard in scheduled helicopter passenger service in New York and Los Angeles, and in Europe.

HELICOPTER HISTORY

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On January 3, 1944, a U. S. Coast Guard Sikorsky R-4 piloted by Comdr. F. A. Erickson flew from Manhattan to Sandy Hook with two cases of blood plasma for survivors of a destroyer explosion. The R-4 made the flight in 14 minutes when other aircraft were grounded by weather and a boat would have taken an hour. The plasma was immediately administered to burn and shock victims. This was the first of the many thousands of helicopter mercy missions.

SIKORSKY AIRCRAFT

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Maser materials are now under way which should uncover paramagnetic salts for use in a variety of frequency ranges. These investigations also are aimed at determining what parameters in the material must be controlled to produce desired bandwidths, gains and power outputs.

Ferromagnetic Amplifier

Within recent months a new type of atomic amplifier, employing ferromagnetic materials, has been demonstrated. The device has been called the garnet Maser by some, but the name is a misnomer because the principle of operation is quite different from devices previously described.

Ferromagnetism, like paramagnetism, is a property which stems from the spin of the electron. There is an important difference, however. In paramagnetic materials, only a small fraction of the spins contribute to the net magnetization effect because thermal agitation prevents many of the spins from lining up with an applied field.

In ferromagnetic materials, however, the election spins are tightly coupled together and act as a unit with the result that nearly all the spins can line up with an applied field. The result is a net magnetization that is very much greater than that of a paramagnetic material. The difference is so great that the paramagnetic material is normally considered to be non-magnetic.

Because the gain of a Maser amplifier is proportional to the total magnetization, ferromagnetic materials should be able to provide far greater gains than paramagnetic. Unfortunately, ferromagnetic materials do not have the required atomic structure for a three-level, or continuous wave, Maser, and their relaxation times are too short for practical operation under pulsed conditions. This explains why a different approach is required to make use of these materials.

Non-Linear Behavior

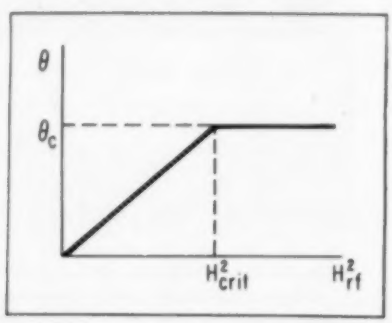
Key to this new approach was the observation of a non-linear behavior of ferromagnetic resonance at high radio frequency power levels. Using the previous gyro-magnet concept, ferromagnetic resonance at low power levels can be explained in the same way as for the paramagnetic material.

This concept, or model, fails when the radio frequency power level is large enough to turn the gyro-magnet through a critical angle (θ) with respect to the steady field. At this critical angle, the gyro-magnet becomes stuck, and if the radio frequency power level is increased further the extra energy fails to budge the gyro-magnet from its fixed angle (θ). Instead the increased energy is transferred non-linearly into other modes of the system, i.e. the ferromagnetic sample and the associated microwave structure. (See sketch.)

This additional energy results in oscillations of the gyro-magnets about their precession paths, a sort of wobble. This wobbling (nutation) of the gyro-magnets couples energy from the driving radio frequency source into modes of oscillation of the crystal, the cavity, or both, which are in resonance with this wobble frequency.

It is this energy, extracted from the crystal or cavity, which produces signal amplification.

In one type of ferromagnetic amplifier, a source of microwave driving power at frequency F_s is supplied



PLOT of precession angle versus RF field strength for ferromagnetic amplifiers.

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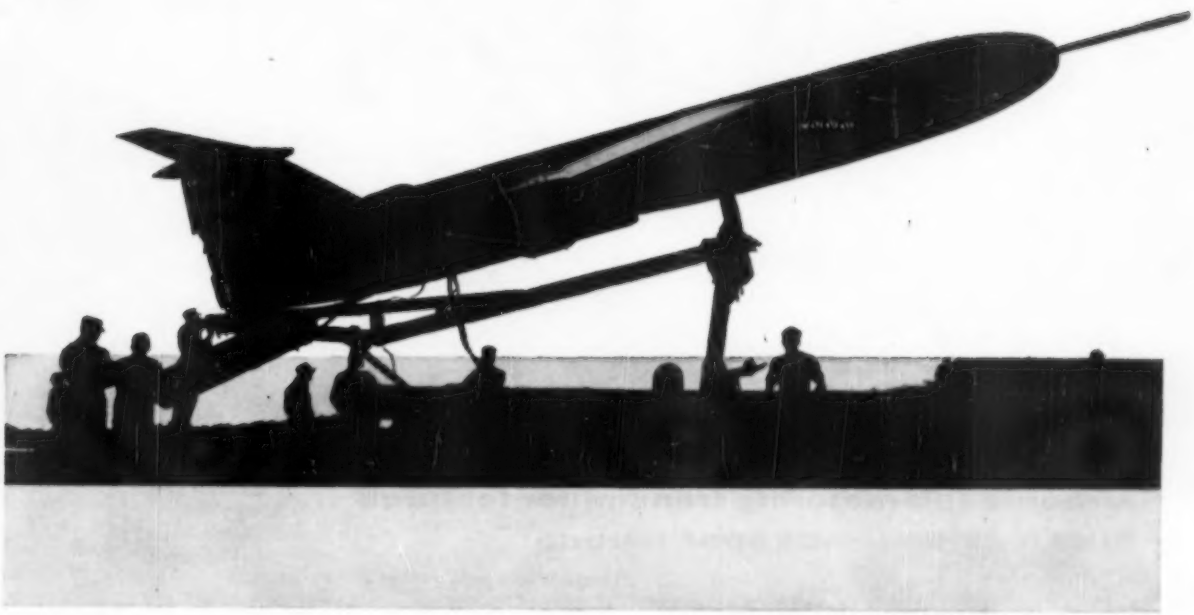

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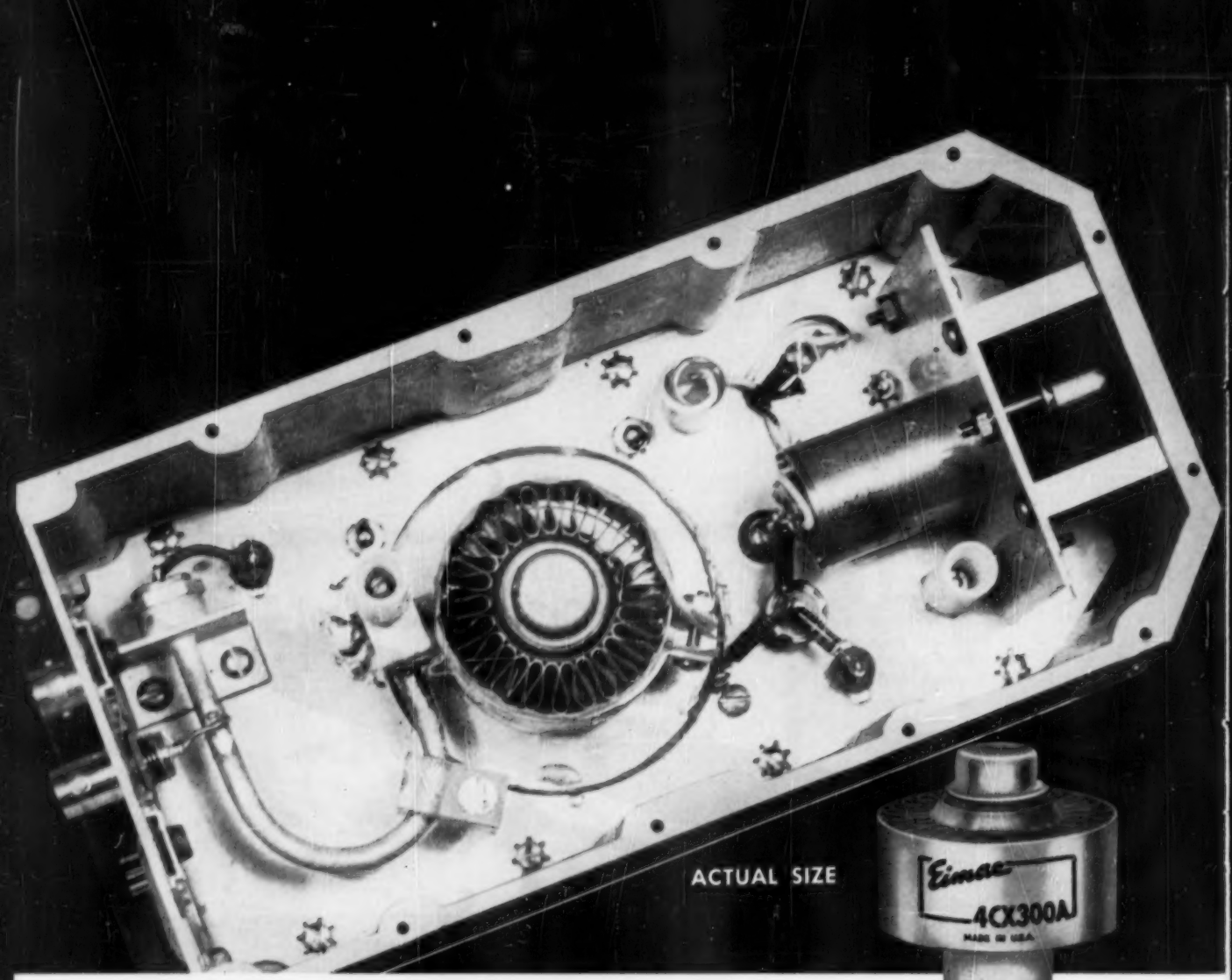

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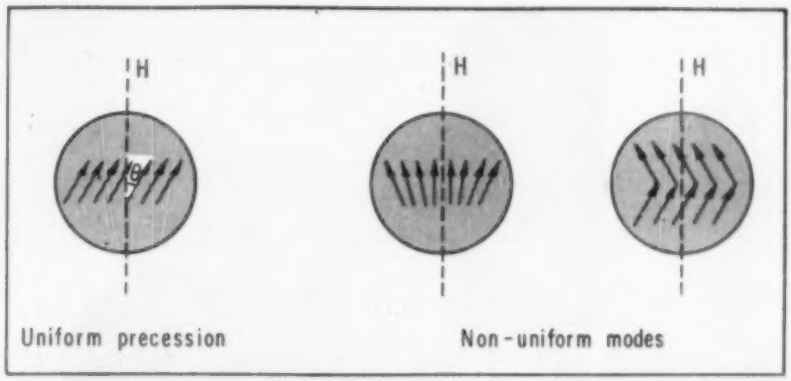
D-C Grid Voltage	−250 max. volts	Screen Dissipation	12 max. watts
		Grid Dissipation	2 max. watts



DISTRIBUTION of magnetization in a ferromagnetic crystal. Precession is usually uniform but non-uniform modes can also exist. Two typical non-uniform modes are shown at right.

through a waveguide to a ferromagnetic crystal mounted in a cavity. A d.c. magnetic field at right angles to the waveguide and with field strength sufficient to cause gyro-magnet resonance at the driving frequency is also used, as with the paramagnetic Maser.

The cavity is designed to be resonant at two frequencies, F_1 and F_2, one of which corresponds to the frequency of the input signal to be amplified. The sum of F_1 and F_2 equals the driving source frequency, F_s. One of the cavity modes must have a radio frequency field component along the d.c. field; the other cavity mode must have a component at right angles to the first.

The radio frequency field aligned with the d.c. field modulates the latter, driving the gyro-magnets in and out of resonance. Non-linear effect produces sideband energy at F_1 (equal to F_s minus F_2) which overcomes cavity losses at F_1 and produces amplification (negative resistance) at this frequency.

Thus, when an input signal (F_1) is applied to the ferromagnetic crystal by means of a strip-line mounted in the center of the waveguide, an amplified output signal at the same frequency is obtained. If frequency conversion were desired, an output signal at frequency F_2 could also be obtained.

Room Temperature Operation

One of the most significant features of the ferromagnetic amplifier is its ability to operate at room temperatures, which opens up entirely new uses for the device. One such amplifier, announced within the past several months, has been operated as both an oscillator and an amplifier at 4,000 mc.

A number of different materials, including ferrites and ferromagnetic metals, appear suitable for use in such amplifiers, but the ferromagnetic ceramics of the garnet crystal structure appear ideally suited. The garnets can be driven into the non-linear region at room temperature with only about one watt of microwave power when mounted in a straight waveguide, or with only milliwatts in a cavity.

Operating temperatures extend up to several hundred degrees centigrade and down to the lowest temperature attainable. Most important, the desirable Maser property of low noise is achieved in the ferromagnetic amplifier. When operated at room temperature, the noise figure is about 3 db., but it drops to only 0.06 db. when cooled to 4K.

Mid-frequency for amplification is determined by the strength of the applied d.c. field, like the paramagnetic Maser, and can range from approximately 100 mc. to 100,000 mc. Bandwidth varies from about 1 mc. to as much as several hundred megacycles. Amount of driving power required goes up as bandwidth increases and may become rather large for the wider bandwidth devices. However it is always less than for a comparable three-level (CW) paramagnetic amplifier.

Larger Gain

Available gain from a ferromagnetic amplifier also is much larger than in paramagnetic devices because of the greatly increased magnetization. Ultimate limitation on the power output is determined by non-linear behavior of the modes at F_1 and F_2 and corresponds roughly to the threshold power level at F_s—the power level required to produce non-linearity.

Wide bandwidth and high power handling capability normally go hand-in-hand, with the consequent requirement for larger driving powers. In this type of device there appear to be no serious power output limitations if one is willing to pay the price in larger driving power.

The gas Maser, first atomic amplifier to be proposed and demonstrated (in 1954), is discussed last because its use is primarily limited to very stable oscillator (atomic clock) applications. But this should not deprecate this very important use.

The gas version differs from the

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solid-state Masers in the use of a completely different technique for supplying energy to the atomic system. It also makes use of a different property of the atoms. Unlike the solid-state device which uses the magnetic dipole moment of the spinning electron, the gas Maser uses the electric dipole moment that exists because some molecules have a non-uniform distribution of positive and negative charge.

The fact that the molecule's electric dipole moment in a gas Maser is 100 times larger than the electron's magnetic dipole moment in a solid-state Maser might be expected to make the former a higher gain amplifier since gain varies with the second power of dipole moment. However, gain also is proportional to the number of contributing electrons or molecules and the extremely low density in a gas, compared to the electron density in a solid, more than counteracts the gas Maser's higher molecular moment.

This makes the gas Maser essentially a low-power device.

Convenient Sorting

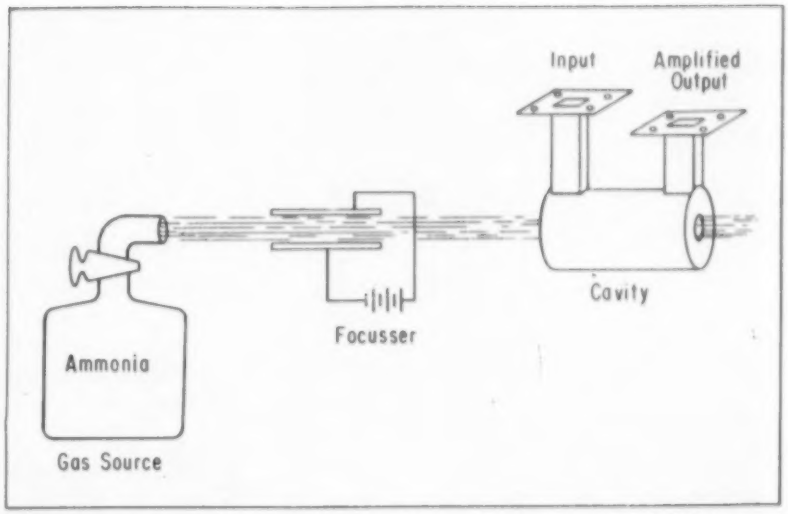
The use of gas makes it possible to use a different technique for sorting out molecules according to whether they are emitting types (with available energy) or non-emitting. Some molecules, for example ammonia, have the property that those molecules in an emitting state prefer to be in a low electric field while those in an absorbing state prefer to be in a high electric field.

In a typical gas Maser, a stream of ammonia molecules of both types passes from a suitable source toward a hole in a microwave cavity. Between the source and the cavity, a system of electrodes is used which produces zero electric field along the center of the molecular stream and a high electric field at the electrodes. This serves to extract the non-emitting type of molecule from the stream, passing on to the cavity only those of the emitting type which contribute to signal amplification.

Room Temperature

The gas Maser can operate at room temperature, except for some cooling of its electrodes to prevent non-emitting (absorbing) molecules from being reflected. Because only emitting molecules enter the cavity, and because there is no crystal lattice to couple heat energy to the molecules as in a solid-state Maser, the gas Maser at room temperature has a low noise figure comparable to a cooled paramagnetic device.

The relatively low molecule density in the gas Maser restricts its output level to small fractions of a microwatt. Another restriction arises because the characteristic frequency of the gas molecules is fixed by their internal structure and can not be changed by varying the strength of an external d.c. field as with the solid-state Maser. This means that operating frequency is fixed and determined by the gas used. The small molecular interactions in a gas also give only a very small bandwidth, typically a few kilocycles.



SCHEMATIC representation of a simple gas Maser. Focusser permits only high energy molecules to enter cavity.

These considerations limit the gas Maser's use as an amplifier but make it extremely valuable as an oscillator. Its fixed frequency provides a universal time standard for a variety of uses. The narrow bandwidth means that oscillator drift will be very small, giving high stability. The low power output is not a very serious limitation.

High Stabilities

Two experimental gas Masers, using ammonia gas and operating at 23,870 mc., remained in synchronism to within 4 parts in 10^{10} for an interval of one second, and showed stabilities greater than one part in 10^{9} for periods of more than an hour. These stabilities are equivalent to a clock that loses less than one second in 100 years operation. There are a number of applications for devices of this type; one, for example, is the newly proposed Navarho-rho long-range navigation system (AW Aug. 5, p. 113).

The Maser's most exciting characteristic, extremely low noise level, is predicted from its theory of operation. Preliminary tests on the few experimental devices built to date appear to confirm this theory, but much more extensive data must be obtained on each of the many proposed versions of the Maser.

Such operating parameters as gain, bandwidth and power output must also be measured under various conditions to determine how closely existing theory can predict device behavior. Many such investigations are now underway in a number of university and industrial research laboratories.

When attempts are made to design a Maser for a specific application, the physicist and engineer will have to work hand-in-hand, applying their joint knowledge of the properties of materials, of interactions of atoms with electromagnetic radiation, of microwave circuit theory and of systems requirements.

Limited knowledge will handicap such efforts. While a great deal of research has been done in the field of magnetic resonance, only a relatively few materials have been intensively studied. A broad program of basic research into the properties of materials will be required before we can develop a variety of Maser types, each with the properties desired for a specific application.

Research Needed

For the paramagnetic amplifier, research must include such studies as the effect of various crystal structures on paramagnetic atoms, measurement of relaxation times, anisotropic effects and the influence of impurities on the material's behavior.

In order to develop a family of atomic clocks which can operate at a variety of frequencies, research is needed to determine the resonant frequencies of various atoms and to improve focusing techniques.

The influence of pressure and temperature on operating parameters is not fully understood and poses some interesting and practical problems.

The very recently developed ferromagnetic amplifier probably is the least understood of all Maser types. Present theory of non-linear behavior is a relatively crude one. It predicts correctly

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the threshold power level for the main resonance, but may be in error when the driving power substantially exceeds this value. The noise figure for the ferromagnetic amplifier cannot be predicted yet with the same certainty as it can for the paramagnetic Maser.

Performance of a Maser or ferromagnetic amplifier is critically dependent upon the microwave structure in which the material is placed and on the circuit connecting the device to the rest of the system.

To eliminate the inconvenience of using a long waveguide, the Maser crystal has been mounted in a cavity, resonant at the signal frequency, to make use of regenerative feedback. However, there are resultant disadvantages. Maser bandwidth is reduced and slight change of circuit parameters may cause the Maser to break into oscillation.

Engineering Study

Microwave engineering skill is needed to develop some new structure which will provide adequate gain and reasonable size without loss of bandwidth or stability. For ferromagnetic amplifiers, and some paramagnetic Masers, the waveguide structure should also be simultaneously resonant at some driving or inverting frequency to reduce amount of auxiliary power required.

The atomic amplifier's low-noise advantages will be largely wasted unless noise generated by warm elements elsewhere in the system is prevented from reaching the device. In the input circuit, losses in the waveguide connecting the Maser to the antenna must be minimized. In the output circuit, radiation from warm load must be blocked. One solution to this problem is the use of ferrite gyrators, which propagate in only one direction, or the more complex circulator.

Because magnetic resonance process employed in Maser operation is itself non-reciprocal, there also is the possibility that the Maser can be made to behave in a uni-directional way, making it insensitive to radiation coming from the output load.

The problems facing the designer of Masers and similar atomic amplifiers are not insignificant, but the potential advantages of these devices are exceptional. Extensive activities now under way in this field should soon provide prototype designs for evaluation. These tests should give a better idea of the ultimate impact of the Maser.

At the present time there is every indication that these new atomic amplifiers will provide dramatic improvements in the performance of radar, countermeasures and communication systems in the UHF and microwave frequency region.

(This is the second of two articles on the Maser.)

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Expansions, Changes In Avionics Industry

Reltron Corp., Newton, Mass., is the name of a new company formed for the manufacture of high temperature subminiature relays. Feature of the Reltron line of relays, according to company president Robert Wadman, will be the ability to operate reliably at temperatures to 250C.

Other recently announced avionic industry expansions and changes include:

• **Vitro Corporation of America** will acquire Nems-Clarke, Inc., of Silver Spring, Md., in exchange for 115,000 shares of Vitro common stock valued at about $3,000,000, according to a joint management announcement.

• **IT&T Components Division** will launch new manufacturing facility in Palo Alto, Calif., initially to produce hermetic seals, selenium and other semiconductor rectifiers. New plant contains approximately 8,000 sq. ft.

• **Bendix Aviation's Computer Division** has announced expansion program to increase output of its general purpose computers by over 100 units annually.

• **General Electric's** Cincinnati jet engine plant has added new IBM memory storage unit, Model 738, to its IBM 704 Data Processing System. Company states that addition of the memory storage unit, with its capacity of 32,768 words, results in the most powerful computer presently available.

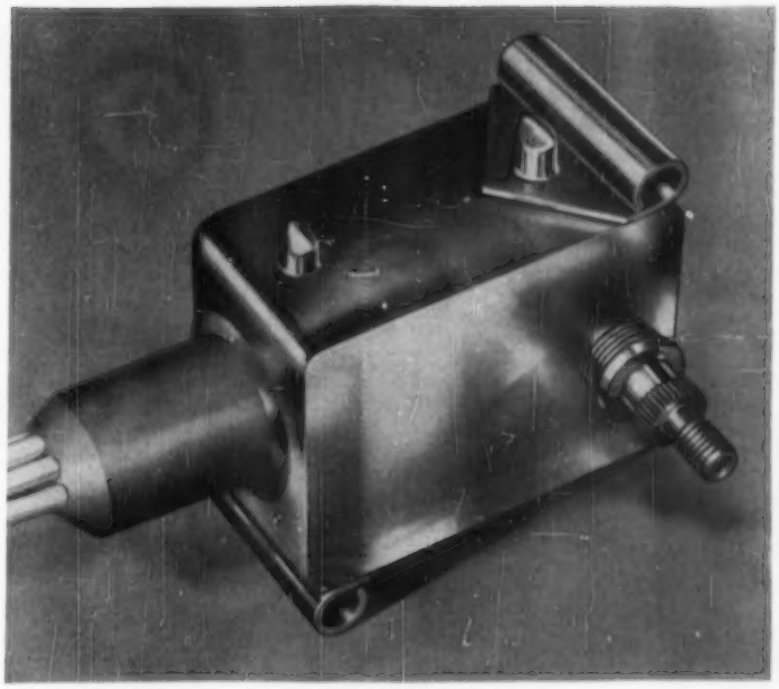
• **National Company, Inc.,** Malden, Mass., has received a Signal Corps Supply Agency contract for $609,525 for the development of military Atomichrons (atomic clocks), according to H. C. Guterman, chairman of the board. Units have uses in missile guidance, radar, navigation, communications and telemetering systems.

• **Avion Division of ACF Industries, Inc.** has consolidated its New Jersey facilities with occupancy of third building in Paramus, (N. J.) Industrial Park off Route 17. A previous mention by AVIATION WEEK did not make clear, only New Jersey facilities were included.

CAA Contracts Study On Radar Coverage

Civil Aeronautics Administration has contracted for engineering study to find methods of improving altitude and range coverage of CAA-operated airport surveillance radars and to improve visibility of small aircraft targets when superimposed on strong fixed ground signals.

CAA ASR's presently average 30 nautical miles range and altitude coverage to 10,000 ft. for small twin-engine aircraft. Contractor is Airborne Instrument Laboratories.



NEW
KLIXON C9178
Rotary Hermetic Switch

Gives you environment-free Precision Switching

The new KLIXON C9178 rotary hermetic switch is designed for such precision applications as aircraft landing gear controls, guided missile launchers, radar equipment, engine controls and industrial equipment.

A double-pole, double-throw rotary assembly, the C9178, has two MS24456 Type hermetically sealed switches enclosed in a steel case to withstand heavy impact and compression loads.

The model illustrated has 360° continuous rotation and is designed for positive drive in both clockwise and counter-clockwise directions. Other units are available with limited rotation and/or spring return. All models can be provided with connectors, potted leads and actuator arms designed to your particular specifications.

Technical data sheets on the C9178 and many other types of hermetic and sensitive switches are available. Write for PRSW Catalog.

FEATURES of the C9178 include:

- **Completely Environment-Free** — basic switches have metal-to-metal, glass-to-metal seals.
- **Simultaneity** — Within 1½° of rotation.
- **Excellent Shock and Vibration Resistance** — shock 50 G's minimum . . . vibration of 40 G's, 0-500 cps, per Procedure I, MIL-E-5272A.
- **High Current Capacity** — 10 amperes resistive, 30 volts DC, 115 volts AC.
- **Minimum Size** — envelope measures 1 29/32" x 1 15/32" x 1 1/32".

Immunity of Ambient Temperature — can be used in ambients from −65°F to +275°F.

METALS & CONTROLS CORPORATION
Spencer Thermostat Division
2809 Forest Street, Attleboro, Mass.
KLIXON

Six of the Lockheed models now in flight test: T2V-1 jet trainer, WV-2 radar search plane, F-104 jet fighter, 1649 Starliner commercial transport, W2V-1 radar search plane, P2V-7 Neptune patrol bomber.

Flight Test Engineering – *the dynamic field for engineers*

A statement by R. L. Thoren, Chief Flight Test Engineer, California Division, Lockheed Aircraft Corporation

The technology of flight test engineering requires an engineer of special ability and aptitude.

There are always a large number of aircraft demanding the ingenuity of professional flight test engineers in a company as diversified as Lockheed. At present there are 30 aircraft – 12 different models – on hand for extensive flight test engineering. In addition, the Electra program, small jet transports and other significant projects will soon swell our schedule.

A major flight test effort such as this calls for an engineer who is flexible, able to cope with changing assignments that vary widely in complexity and approach. He must be able to engineer on his feet; the desk-bound man is out-of-place in as dynamic a field as flight test. Moreover, he must possess ability in breadth. He is no specialist in a single phase of engineering. His assignments cover the entire aircraft. And as flight testing begins in preliminary design under our philosophy of engineering, he participates actively in design and development of all Lockheed aircraft from that stage through completed testing. Needless to say, a flight test background at Lockheed helps qualify an engineer for virtually any key engineering position in the company.

Our expansion program has created new positions for Flight Test Engineers, Flight Test Analysts and Instrumentation Engineers with those attributes. Many of the positions are on a senior level and will particularly interest engineers with flight test experience. I have asked E. W. Des Lauriers, manager of our Placement Staff, Dept. 03084, to give your inquiry his fullest attention.

Architect's drawing of Lockheed's new Burbank flight test engineering and experimental center. It is scheduled for occupancy September, 1957.

California Division

LOCKHEED

AIRCRAFT CORPORATION

BURBANK, CALIFORNIA

These Men Head Reorganized CAA

Civil Aeronautics Administration next month will complete its first year of operation under the organizational structure conceived by the late Charles J. Lowen. This reorganization, placing emphasis on traffic control, was implemented by James T. Pyle, who succeeded Lowen as CAA head.

ADMINISTRATOR
James T. Pyle

DEPUTY ADMINISTRATOR
William B. Davis

ASSISTANT ADMINISTRATOR
Samuel A. Kemp

ASSISTANT TO THE ADMINISTRATOR
Preble Staver

PERSONNEL OFFICE
J. Meisel

BUDGET AND FINANCE OFFICE
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GENERAL COUNSEL'S OFFICE
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D.M.Stuart
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B. H. Griffin

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Reg. 2 - L. C. Elliott
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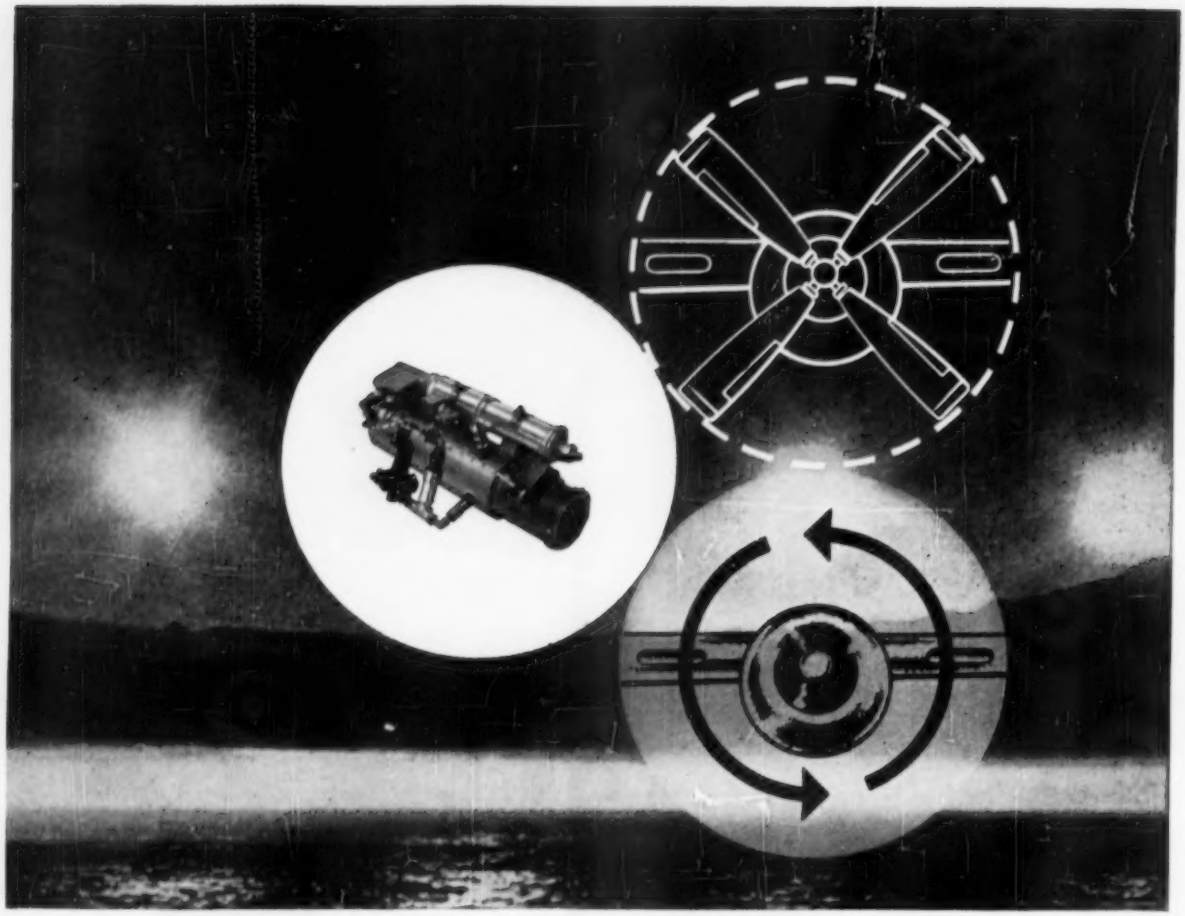
Reg. 3 - L. W. Jurden
Kansas City, Mo.

Reg. 4 - W. P. Plett
Los Angeles, Calif.

Reg. 5 - A. D. Hulen
Anchorage, Alaska

Reg. 6 - J. M. Beardslee
Honolulu, T.H.



new light on a cold problem by

Janitrol

In the land of the midnight sun—or anywhere the temperatures drop down to −65°F and stay there—Janitrol hot fuel prime systems provide positive engine starting in a matter of minutes.

In a series of tests for example, a Curtiss-Wright turbo-compound engine which had been cold soaked for three solid days at −65°F was started in 60 seconds and running clear in 3 minutes. This was not an isolated example. The Janitrol unit does it repeatedly.

The unit is less than 18 inches long, weighs under 16 pounds, heats fuel from −65°F to 200°F and supplies hot fuel at the rate required as long as necessary to insure smooth starts.

Janitrol's broad experience in solving such problems has led to other important developments: such as Janitrol high-temperature high-pressure couplings; pneumatic controls, heat exchangers, and purge gas systems. Call your nearby Janitrol representative. Janitrol Aircraft-Automotive Division, Surface Combustion Corporation, Columbus 16, Ohio.

Stock Transactions

Washington—Acquisition of 2,476,142 common shares of Trans World Airlines, Inc., stock by exercise of rights, etc., by The Hughes Tool Co., beneficial owner, has been reported by the Securities and Exchange Commission. Hughes Tool Co. total is now 4,952,284. Other transactions reported from June 11 to July 10 include:

ACF Industries, Inc. Acquisition of 400 common shares by J. F. Clark, officer and director, for a holding of 1,100.

Aero Supply Manufacturing Co., Inc. Acquisition of 2,000 common shares by Henry M. Margolis, director, for a holding of 46,861, with the Henmar Investing Corp. beneficially holding 26,335 common shares.

Aeroquip Corp. Disposal of 200 common shares by Frederic W. Corwin, officer, leaving a holding of 16,478; disposal of 200 common shares by Charles Hollerith, officer and director, leaving a holding of 16,212.

Air Reduction Co., Inc. Acquisition of 1,500 common shares through exercise of option and disposal of 500 common shares by Jack D. Gunther, officer, leaving a holding of 2,834; disposal of 500 common shares by David H. Lyall, officer, leaving a holding of 625; disposal of 100 common shares by T. Stanley O'Brien, officer, leaving a holding of 100; disposal of 400 common shares by August J. Thoma, officer, leaving a holding of 2,087.

Air-Way Industries, Inc. Acquisition of 14,402 and disposal of 13,785 common shares by holding companies listed under Edward Lamb, officer, for a holding of 57,820 with Lamb directly holding 41,268; acquisition of 400 common shares by Edward Lamb Enterprises, a beneficial owner, for a holding of 391,548, with the Unity Corp., listed under Edward Lamb Enterprises, disposing of 685 common shares, its entire holding; acquisition of 7,747 common shares and disposal of 4,904 common shares by holding companies listed under Prudence H. Lamb, a beneficial owner, for a holding of 120,388 with Mrs. Lamb beneficially holding 50,263 common shares.

American Bosch Arma. Disposal of 600 common shares by Edmund D. Gittens, officer, leaving a holding of 150; disposal of 100 common shares owned beneficially by a holding company listed under William S. Wasserman, director, leaving a holding of 13,900 with Wasserman directly holding 12 common shares, and trusts listed under Wasserman beneficially holding 4,969 common shares.

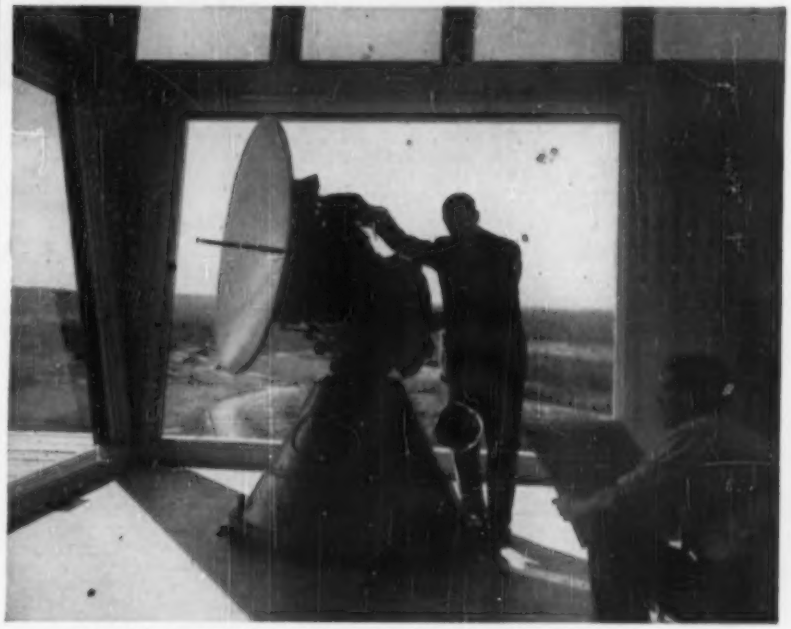
Avco Manufacturing Corp. Disposal of 300 preferred shares by A. B. Newton, officer, leaving a holding of 100.

Atlas Corp. Disposal of 500 option warrants by Mrs. James Allen, a beneficial owner listed under her husband, leaving a holding of 300.

Bendix Aviation Corp. Acquisition of 500 common shares through exercise of option by Henry A. Gossner, officer, for a holding of 1,250; acquisition of 2,000 common shares through exercise of option by W. H. Houghton, officer and director, for a holding of 4,283; acquisition of 1,000 common shares through exercise of option by Charles Hummel, officer, for a holding of 1,714; acquisition of 400 common shares through exercise of option and purchase of 10 common shares and exchange of 566 common shares of Sheffield Corp., by Raymond P. Lansing, officer and director, for a holding of 77,490.

California Eastern Aviation Inc. Acquisition of 1,812 and disposal of 1,000 common shares by William W. Brinckerhoff, officer and director, for a holding of 80,711; acquisition of 1,100 common shares by Edward A. Kerbs, director, for a holding of 7,261; disposal of 1,800 by S. J. Solomon

ENGINEER OPPORTUNITIES AT RAYTHEON



AT RADAR ANTENNA IN OBSERVATION TOWER overlooking Raytheon's Flight Test Facility at Bedford, Mass., engineers work on vital missile projects in an informal atmosphere that stimulates creativity.

Advanced work with prime contractor for Army Hawk and Navy Sparrow III

The caliber of Raytheon engineering is an indication of the quality of our staff. Raytheon is the only electronics manufacturer with prime contracts involving complete systems responsibility for both air-to-air and surface-to-air missiles.

As an engineer in our Missile Systems Division, you associate with men of top national reputation in stimulating small groups. Our expanding development has created interesting openings in:

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ELECTRONICS PACKAGING	TECHNICAL WRITING
SYSTEMS	AERODYNAMICS
MICROWAVE	STRUCTURES
ANTENNA DESIGN	MECHANICAL DESIGN
TUBE APPLICATIONS	HEAT TRANSFER

Please send brief outline of your background to G. P. O'Neil, Raytheon Missile Systems Division, Box 8A, Bedford, Mass.

RAYTHEON MANUFACTURING COMPANY
Missile Systems Division
Bedford, Massachusetts

Are you the ONE MAN IN THREE?

RAYTHEON

Excellence in Electronics

Putting the screws on a tornado

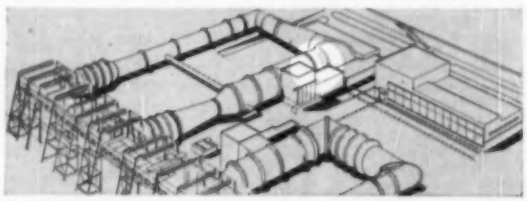
The supersonic wind tunnel under construction at Tullahoma, Tennessee, combines some of the most gigantic construction with some of the most precise electronic controls in the whole history of aircraft testing.

The project simulates conditions of flight in excess of 16 miles altitude, from Mach 1.5 to approximately Mach 4.5. Some of the statistics of design are startling, even in today's world of wonders.

The nozzle walls of the tunnel are solid steel, 100 feet long, 16 feet high. To reach any one of 300 master positions, these plates are moved by 56 huge screw jacks on each side—with a tolerance for error restricted to 8 one-thousandths of an inch in an 8-foot stroke! Each jack "talks back" electronically to Master Control, reporting its position. Provision is made for remote starting and operation by magnetic tape programming, set up in advance.

Two associated companies are doing this job—the Electric Boat and Stromberg-Carlson divisions of General Dynamics Corporation. Electric Boat—builders of the atomic-powered submarines, *Nautilus*, *Seawolf* and *Skate*—has overall responsibility, will supply the jacks and design the servo mechanisms. Stromberg-Carlson is to create and build the digital computer system for the electronic controls.

This project—combining heavy, giant-size, accurate "machinery" with electronic systems of a complex, automated nature—is typical of the service which General Dynamics divisions offer.



Sketch of the project, being built by the U.S. Army Engineers for the U.S. Air Force, Arnold Engineering Development Center. Circled area locates the special walls and nozzle.

S-C

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

General Offices and Factories at Rochester, N. Y.—West Coast plants at San Diego and Los Angeles, Calif.

GD

& Sons, listed under S. J. Solomon, officer and director, the firm's entire holding with Solomon directly holding 28,148 common shares.

Continental Air Lines, Inc. Acquisition of 600 common shares through exercise of option by S. B. Redmond, officer, for a holding of 1,375.

Curtiss-Wright Corp. Acquisition of 700 common shares through exercise of option by James G. Byron, officer, for a holding of 8,200; disposal of 17,500 common shares, by Roy T. Hurley, officer and director, leaving a holding of , 42,500 with Mrs. Hurley beneficially holding 100 common shares, listed under her husband.

Eastern Air Lines, Inc. Acquisition of 600 common shares by Laurance S. Rockefeller, director, for a holding of 94,300 with a trust li.ted under Rockefeller beneficially holdiag 3,542 common shares.

Emery Air Freight Corp. Disposal of 100 common shares by Walter G. Corcoran, officer, leaving a holding of 2,269; acquisition of 100 common shares by John C. Emery, officer and director, for a holding of 22,140.

Fairbanks Morse & Co. Disposal of 800 common shares by Mrs. William S. Covington, beneficial owner listed under her husband, leaving a holding of 5,620, with trusts listed as beneficial owners under Covington holding 940 common shares and William S. Covington, director, directly holding 1,300 common shares; disposal of 800 common shares by John A. Cuneo, officer, leaving a holding of 500; disposal of 400 common shares by James S. Kemper, director, leaving a holding of 100 with Lumbermens Mutual Casualty Insurance Co., listed as a beneficial owner under Kemper, disposing of 1,000 common shares, leaving a holding of 200, and Excess Underwriters, Inc., also listed under Kemper, disposing of 500 beneficially owned common shares, the entire holding; disposal of 900 common shares by Robert H. Morse III, officer, leaving a holding of 400; acquisition of 17,600 common shares in open market and acquisition of 24,000 common shares not in the open market and disposal of 300,000 common shares by the Penn-Texas Corp., listed as a direct beneficial owner, for a total holding of 408,150; acquisition of $2,000 worth of 5¾% convertible subdebentures by Orren S. Leslie, officer, his entire holding; acquisition of $200,000 worth of 5¾ convertible sub-debentures by the Penn-Texas Corp., listed as a direct beneficial owner, its entire holding; acquisition of $3,000 worth of 5¾ convertible subdebentures by E. T. Sandeen, officer, his total holding; acquisition of $5,000 worth of 5¾ convertible sub-debentures by Lester W. Stolte, officer and director, his total holding.

Fairchild Engine & Airplane Corp. Acquisition of 125 common shares by Floyd S. Bennett, Jr., officer, for a holding of 325; acquisition of 300 common shares by Paul S Cleveland, officer, for a holding of 513; acquisition of 500 common shares by A. F. Flood, officer and director, for a holding of 1,183 with Flood acting as a trustee beneficially holding 1,525 common shares; acquisition of 500 common shares by William Preston Lane, Jr., director, for a holding of 2,600 with Mrs. Lane listed under Lane as a beneficial owner, holding 600 common shares. Lane, jointly with Mrs. Lane acquired 300 common shares beneficially for a holding of 800.

Flying Tiger Line, Inc. Acquisition of 100 common shares by William E. Bartling, officer, for a holding of 605; acquisition of 100 common shares by George T. Cussen, officer, his total holding.

General Electric Co. Acquisition of 1,125 common shares, through exercise of option, by John W. Belanger, officer, for a holding of 12,263; disposal of 400 common shares by Ralph J. Cordiner, officer and director, leaving a holding of 13,655; acquisition of 900 common shares, through exercise of option, and disposal of 300 common shares, by George L. Irvine, officer, for a holding of 2,648; acquisition of 3,225 common shares, through exercise of option, by Roy W. Johnson, officer, for a holding of 12,275; acquisition of 1,400 common shares through exercise of option, by H. A. MacKinnon, officer, for a holding of 5,927; acquisition of 3,088 common shares, through exercise of option, and disposal of 1,000 common shares by Gerald L. Phillippe, officer, for a holding of 5,769; disposal of 1,200 common shares by Phillip D. Reed, director, leaving a holding of 6,900; acquisition of 1,875 common shares, through exercise of option, by Harold F. Smiddy, officer, for a holding of 7,500; acquisition of 2,352 common shares, through exercise of option, and disposal of 690 common shares by Arthur F. Vinson, officer, leaving a holding of 7,036.

McDonnell Aircraft Corp. Acquisition of 200 common shares by William R. Orthwein, Jr., officer and director, for a holding of 11,476.

National Aviation Corp. Disposal of 200 common shares by Frederick F. Robinson, officer, leaving a holding of 100; disposal of 500 common shares by Elmer Wellin, director, leaving a holding of 2,800.

Northeast Airlines, Inc. Acquisition of 4,600 common shares by the Atlas Corp., listed as a beneficial owner, making a holding of 926,726; acquisition of 100 common shares by Radu Irimescu, director, his total holding.

Republic Aviation Corp. Disposal of 1,254 common shares by John J. Ryan, officer, leaving a holding of 100.

Seaboard & Western Airlines, Inc. Disposal of 200 common shares by Raymond A. Norden, officer and director, leaving a holding of 58,163.

Skiatron Electronics & Television Corp. Disposal of 900 common shares by Frank V. Quigley, officer and director, leaving a holding of 935; disposal of 1,000 common shares by Kurt Wilder, director, leaving a holding of 7,900.

Solar Aircraft Co. Acquisition of 100 common shares by a trust listed under Richard R. Rollins, director, leaving a beneficial holding of 100, with Rollins

FREE BOOKLET... tells about working with "the leaders" on exciting advanced projects

We're proud of our men and of the work they do. We'd like you to become better acquainted with the setting in which they work, live and play.

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RECOGNITION We help our people realize their fullest capabilities—pay accordingly. Deserving persons advance rapidly.

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Servomechanisms
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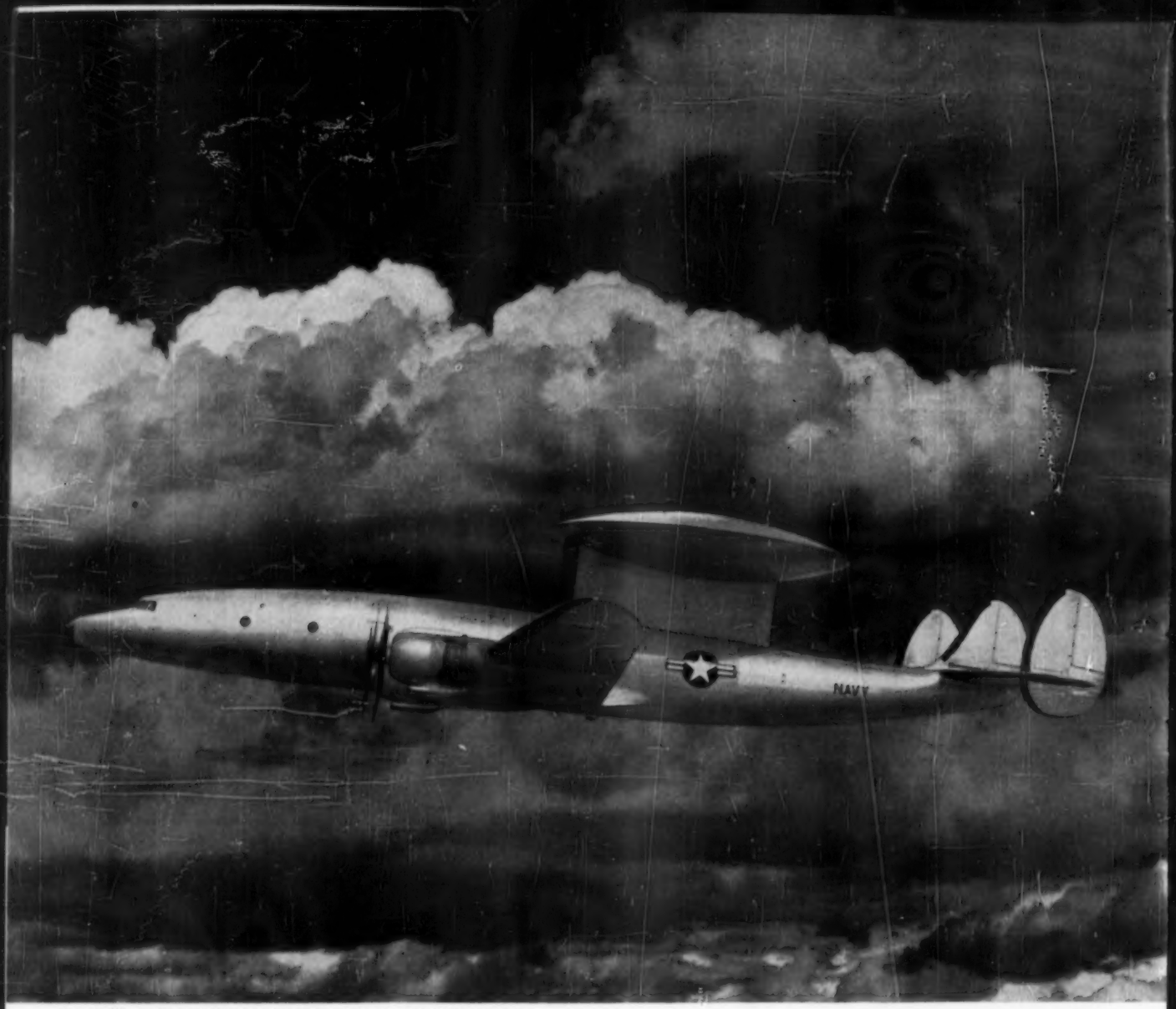


Famous "Flying Saucer" Rotodome for the Navy's Lockheed WV-2 Constellation

Bring your tough ones to Zenith

This giant Rotodome was an engineering nightmare. It represented a whole new concept in Early Warning Radar equipment. Its airfoil shape and great size—38 feet in diameter—were a radical departure in radome design. It had to combine high strength with light weight, so that it could be *rotated in flight* with the radar antenna.

Working in close cooperation with Lockheed's engineers, we made the Rotodome of resin-bonded glass fiber. It met every requirement for strength, weight, and electronic consistency. And the entire job was completed—designed, engineered, tooled, fabricated, and delivered—*in 120 days.*

This is the kind of challenge we welcome at Zenith. We've learned how to form resin-bonded glass fiber in almost any shape and size... at production-line speed. We can simplify designs because structural plastics often eliminate the need for interior bracing. We can usually complete tooling in a fraction of the time needed for metal parts—and at lower cost.

Zenith's reinforced plastics are the *only* answer for some structural components—and a better answer for many. We invite you to "bring your tough ones to Zenith."

World's Largest plant producing reinforced plastics components for the U. S. Air Force, U. S. Army, and U. S. Navy. Applications include Aircraft and Missile Radomes • Helicopter and Missile Fuselage Sections • Aircraft and Missile Wings • Fairings • Fuel Tanks • Fire Bombs • Rescue Containers • Bomb Casings and Fins • Rocket Launcher Pods • Antenna Reflectors • Arctic Shelters • Boats • Minesweepers • Landing Craft • Small Sailing and Power Craft • Naval Craft Components • Buoys and Floats • Ducting • Ground Rigid Radomes • Land and Aerial Mine Housings • Shipping Containers • Storage Tanks

Zenith Plastics Company

1600 West 135th Street, Gardena, California

Subsidiary of Minnesota Mining and Manufacturing Company

3M

FORM OF THE FUTURE: RESIN-BONDED GLASS FIBER

directly holding 500 common shares.

Sperry Rand Corp. Disposal of 300 common shares by H. C. Landsiedel, officer, leaving a holding of 5,620; disposal of 8,000 common shares, beneficially held in a joint ownership listed under Harry Landsiedel, officer, leaving a holding of 18,960 with Landsiedel directly holding 13,904 common shares.

Temco Aircraft Corp. Acquisition of 33,900 common shares and disposal of 3,015 common shares, through exchange for other stocks, by D. H. Byrd, director and beneficial owner, for a total holding of 143,958 with Mrs. Byrd disposing of 1,000 common shares leaving a beneficial holding of 32,860 listed under Byrd, with D. H. Byrd trust beneficially holding 33,807 and Caruth Byrd trust beneficially holding 33,807 common shares.

United Air Lines, Inc. Disposal of 900 common shares by Thomas F. Gleed, director, leaving a holding of 146; disposal of 500 common shares by Charles F. McErlean, officer, leaving a holding of 2,101.

Western Air Lines, Inc. Acquisition of $15,000 worth of convertible sub-debentures by Dudley Swim, director, for a holding of $331,000.

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts as released by the Air Materiel Command.

Sikorsky Aircraft, United Aircraft Corp., Stratford, Conn. Helicopters, spares, special tools and technical data. (H-19D) (MIPR R-57-703-TC and PR 631947) $2,717,000.

Beech Aircraft Corp., Wichita, Kans. L-23D airplanes, spare parts, data special tools and GHE for Department of the Army (MIPR-57-709TC) $300,000.

United Manufacturing and Engineering Corp., 31st and Noland Rd., Independence, Mo. Trailer, oil servicing, type A-1B, 600 gallon capacity, aluminum tank, 1 ea. (MIPR-20-113-TcVU-57-1 and Amendments 1 and 2) $156,600.

Continental Motors Corp., 205 Market St., Muskegon, Mich. 6-470-15 engines for TL-19D aircraft. Maintenance and engineering data. (PR PE-7-02A-4117) $1,036,729.

Sundstrand Aviation Div., Sundstrand Machine Tool Co., 2421 11th St., Rockford, Ill. Valve boost pump negative "G" (Instl). Diverter valve (instl) for support of F-100D aircraft. (PR OC-726007) $669,903.

AiResearch Manufacturing Co., Division of Garrett Corp., Arizona Div., Phoenix, Ariz. Starters, combustion, aircraft engine type MA-10, for KC-135A aircraft. (PR PE-630815) $373,673.

Fairchild Camera and Instrument Corp., Robbins Lane, Syosset, Long Island, N. Y. Lens cone, aerial camera, type LA-51 for B-52D aircraft. (PP564668, 564669-1, and 564710) $160,385.

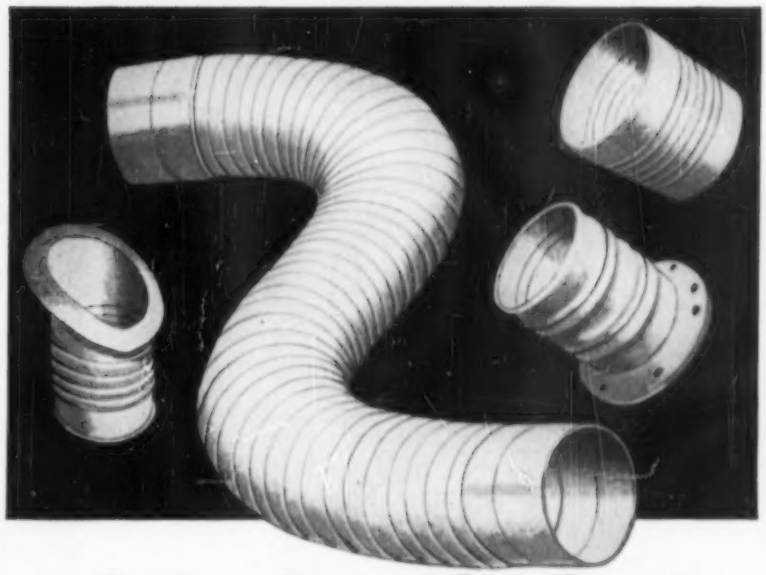
Defense Electronic Products Div., Radio Corp. of America, Front and Copper Sts., Camden, N. J. Product improvement of AN/ARC-21 radio set to the AN/ARC-65 radio set, 14 ea. (PR PE-7-16A-4524) $297,982.

Bell and Howell Co., 7100 McCormick Rd., Chicago 45, Ill. Firing error indicator pods used in reconnaissance aircraft. (MIPR R57-2284-131) $586,903.

Apparatus and Optical Div., Eastman Kodak Co., 400 Plymouth Ave., N., Rochester 4, N. Y. Navy type KB9 (A) camera and electrical attachment plates for use with Navy reconnaissance aircraft. (MIPR R57-2268-103-Aer; Amendments 1 and 2) $463,398.

J. A. Maurer, Inc., 37-01 Thirty-first St., Long Island City 1, N. Y. Navy type KB-0A camera, 55 ea. 50 foot film magazine for KB-10A camera, 131 ea. Maurer type P-220 camera w/50' magazine, 4 ea. (MIPR R57-2259-77 Aer and PR PE-7-10D-4160) $115,003.

Akeley Camera and Instrument Div., J. W. Fecker Inc., 160 Varick St., New York, N. Y. CR-1a camera, radarscope re-



facts about Flexflyte®

that will help you solve your aircraft ducting problems

What is Flexflyte?
A lightweight, reinforced ducting made of a spring steel wire helix covered with coated fiber glass or a cotton fabric and bound with a fiber glass cord.

What are its applications?
Flexflyte is designed for use with ventilating, defrosting, de-icing and hydraulic systems.

How flexible is Flexflyte?
It will take tight turns at any point up to 180° without buckling. No elbows or fittings are required.

What are its temperature ranges?
From minus 120°F. to plus 650°F.

What about Flexflyte's resistance to abrasion?
It is highly resistant to abrasion, especially when coated with FT-506 which has more than 200 times the abrasion resistance of any tubing of its type and weight.

Is it flame resistant?
Flexflyte has exceptionally high flame resistance and will not support combustion.

What pressures will Flexflyte handle?
Internal working pressures up to 70 psi and external working pressures up to 15 psig, depending on type.

What about installation?
Flexflyte is quickly, easily installed around corners and equipment parts by means of metal clamps. It is also available with special enlarging or reducing ends, either cylindrical, rectangular or polyhedral.

Can Flexflyte be engineered for unusual applications?
Yes, in many special shapes, fabrics, coatings, connections, lengths and diameters. Our special Silicone Department, working with automated machinery, is prepared to meet any requirement for silicone ducting.

How can I make sure that Flexflyte will solve my problems?
Write us, outlining your requirements. Our engineers will be glad to put their experience to work for you. Write Dept. 208.

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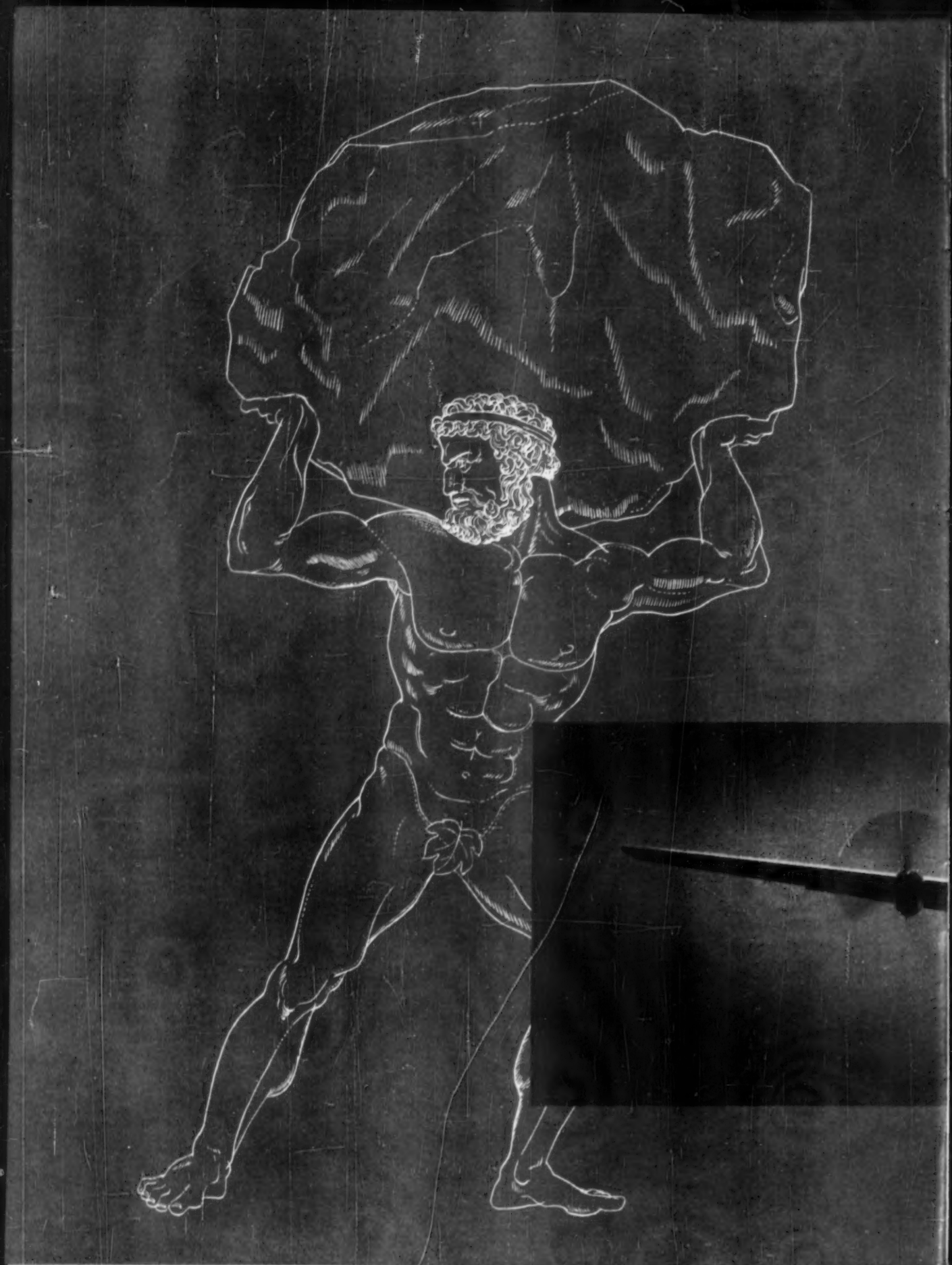

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The new Hercules C-130B is a logistics version of the performance-proved C-130A—which has performed impressive feats with the Tactical Air Command.

Powered by four 4050 h.p. Allison T-56 prop-jet engines, the Hercules can carry 25,000 pound loads 3,500 miles, at cruise speeds over 300 knots (or carry 35,000 pounds for 2500 miles).

The first jet age aircraft specifically designed for air freight, the new Hercules has a huge rear door and integral loading ramp—enabling it to swallow whole truckloads at a gulp. No other cargo plane in USAF operational service can match the Hercules in fast loading and unloading—of all types of cargo, no matter how big or heavy.

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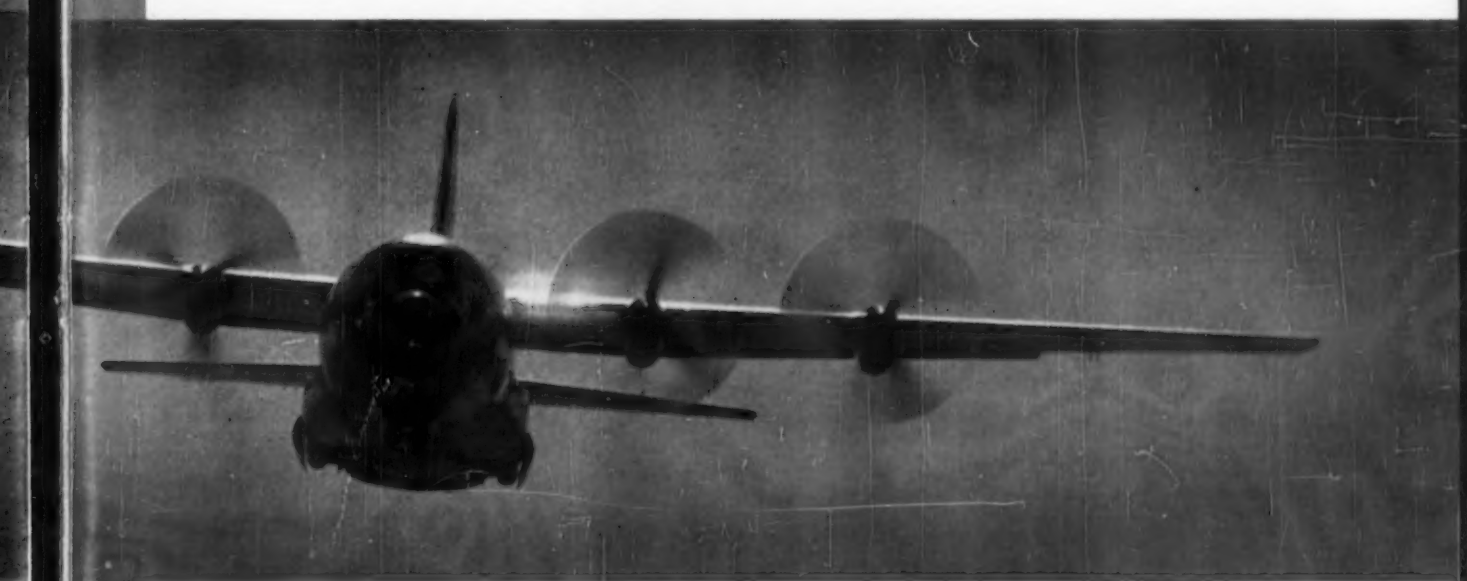
GEORGIA DIVISION, *Lockheed Aircraft Corporation, Marietta, Georgia*



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cording, 140 ea. MR-1a magazine for above camera 140 ea. (MIPR R57-2257-68 Aer.) $157,000.

Jack & Heintz, Inc., 17600 Broadway Ave., Cleveland 1, Ohio. Generators, 30 kva, 3 phase, type MB-2 panels, control, AC generator, regulators, voltage, aircraft generator, Mag-Amp used for F-102 aircraft (PR PE-631807 and SA-729420) $123,301.

Schweizer Aircraft Corp., Elmira, N. Y. Model 2-22A sailplane; model 1-26B sailplane. Spare parts for items 1 and 2. (PR PH-7-91A-7059) $31,971.

Lycoming Div., Avco Manufacturing Corp., 652 Oliver St., Williamsport, Pa. Aircraft engines (0-435-23A) for H-13H aircraft. (MIPR-R57-702-TC, Amendment No. 4) $242,730.

Hoover Electric Co., 2100 South Stoner Ave., Los Angeles 25, Calif. Actuator-Electro-Mechanical Linear, data, spare parts for F-86H aircraft. (PR SA-639703 and SA-639703-1) $189,615.

Sundstrand Aviation Div., Sunstrand Machine Tool Co., 2421 Eleventh St., Rockford, Ill. Frequency & load controllers, automatic parallel controls for B-66 aircraft. (PR 729426, 729489 and 631821) $50,635.

Atchison Leather Products, 316 Commercial St., Atchison, Kans. Belt aircraft, safety, lap type MD-2 (PR PE-630806, PE-630806-1, PE-630806-2, OC-726176, R57-2543-TCSMC-E, PE-7-03F-3044, PE-7-03F-3045 and 630805) $84,946.

Aerial Machine and Tool Corp., 38-27 30th St., Long Island City, N. Y. Harness aircraft, safety personnel type MA-1, belt aircraft, safety, lap troop type MC-1, shoulder harness type D2 (PR PE-630804, PE-630822, PE-630821, PE-630816, PE-630816-1, PE-630817, and OC-733052) $240,-903.

Red Bank Div., Bendix Aviation Corp., Eatontown, N. J. Generators, D. C., 30 volt, 100 amp., 2500 to 4500 rpm. P/N 30E16-11-C for C-45G and C-45H aircraft. Maintenance data, engineering and lubrication data for C-45G aircraft and C-45H aircraft. (PR SA-639679) $145,887.

USAF Contracts

Following is a list of unclassified contracts for $25,000 and over, as released by Air Force Contracting Offices:

DAYTON AIR FORCE DEPOT, Gentile Air Force Station, Dayton 10, Ohio.

The Jackson Electrical Instrument Co., 18 So. Patterson Blvd., Dayton 2, Ohio. Junction box J-229 ARM-14 a/w mil spec MIL-J-8093 (USAF) dtd 14 Oct 52 & MD #2 dtd 3 Mar 54 & Contractor's Engineering change proposal No. 1 dtd 1 Feb 57 103 ea. PR's 609014 & 609016 $56,598.

Aircraft Products Co., Church Road, King Manor, Bridgeport, Pa. Test set, pilot static, type MB-1 a/w spec MIL-T-8076A (ASG) dtd 3 Feb 53 & Amd #2 dtd 18 Oct 54, 338 ea. Engineering data IFB 33-604-57-318 $96,768.

Sperry Gyroscope Co., Div. of Sperry Rand Corp., Great Neck, N. Y. Maintenance spare parts for ground, portable ignition and vibration analyzer PR628429, $258,-788.

Liquidometer Corp., Skillman Ave. and 36th St., Long Island City, N. Y. Tester, capacitance type, fuel quantity gage a/w Spec MIL-T-4687A dtd 10 Mar 55 140 ea. PR 80657 $106,820.

K. W. Johnson & Co., 1825 Webster St., Dayton 4, Ohio Kit: consisting of: a. 2 ea. insulator-vibration, all metal cup, 51-21 lbs., MS-91418-2BHS, a/w MIL-C-172B, And #2 dtd 11 Sep 56 & suppl IC dtd 11 Sep 56. b/2 ea. insulator-vibration, all metal cup, 20-28 lbs, MS-91418-2BJS a/w MIL-C-172B, Amd #2 dtd 11 Sep 56 & suppl IC dtd 11 Sep 56 17,960 ea. Kit: consisting of 2 ea insulator-vibration, all metal cup, 20-28 lbs MS-91418-2BJS a/w MIL-C-172B, Amd #2 dtd 11 Sep 56 & suppl IC dtd 11 Sep 56 240 ea. RFP 33-604-57-2589 $89,753.

Hallicrafters Co., 5th & Kostner Ave., Chicago 24, Ill. Transmitters, radio, T-465/ALT-7 167 ea. Handbook data, engineering data, power supplies PP-506/APT-6 462 ea. PR's 688167 & 688168 $533,909.

Bruno-New York Industries Corp., 460 W. 34th St., New York 1, N. Y. Multimeter AN/PSM-6 2081 ea. PR's 80852, 609060 & 80402 $152,433.

Advance Industries Inc., 640 Memorial Drive, Cambridge 39, Mass. Boresighting set AN/GPM-14 a/w MIL Spec MIL-B-9093 (USAF) dtd 10 Feb 54 218 ea Photographs w/one negative, glossy 3 ea. PR's 628372, 80550, R-57-132-29069-E 2/6ASO $344,671.

Amphenol Electronics Corp., 1830 South 54th Ave., Chicago 50, Ill. Test bench group, air portable, type A-1, 60 ea. PR's 101002 & 101085 $774,000.

Webcor, Inc., Government Div., 816 N. Kedzie Ave., Chicago 52, Ill. Recorder, RO-26/ALH-2 237 ea. control, C-1651/ALH-2 360 ea. Mounting, MT-1548/ALH-2 340 ea. Magazine, MA1/ALH-2 829 ea. PR688183 & Amd #1 $368,026.

Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif. Velocity pick-up, contractor's P/N 4-102A 368 ea. PR 93031 $78,453.

SAN ANTONIO AIR MATERIEL AREA, USAF, Kelly AFB, Tex.

Airtron, Inc. 1101 W. Elizabeth Ave., Linden, N. J. Aircraft accessory spare parts, 5 items. PR. SA-7-03C2-1362 and 1342 $48,355.

General Electric Co., 1801 North Lamar St., Dallas 2, Texas. Aircraft accessory spare parts, 9 items. PR. SA-715431 $409,172.

Gilfillan Bros, Inc., 1815 Venice Blvd., Los Angeles 6, Calif. Aircraft accessory spare parts, 6 items. PR: SA-639683 and SA-639686 $280,632.

Allison Div., Allison Plant #5, General Motors Corp., Indianapolis, Ind. Aircraft accessory spare parts, 5 items. PR: SA-640371, SA-640371-1, SA-640371-2, SA-640371-3, and SA-640371-4 $162,161.

Holley Carburetor Co., 12350 East Nine Mile Rd., Van Dyke, Mich. Aircraft accessory spare parts, 39 items. PR: SA-640473 and SA-640478-1 $96,262.

MIDDLETOWN AIR MATERIEL AREA, USAF ,Olmstead AFB, Pa.

General Electric Co., 40 Federal St., West Lynn, Mass. Thermocouple assemblies (RFP PR MA-650038) and Amend No. 1; 5,528 ea. $483,147.

Air Products, Inc., P. O. Box 538, Allentown, Pa. Liquid oxygen and liquid nitrogen (RFP PR MA-662082) 65,266 tons. $1,084,323.

Mills Mfg. Corp., P. O. Box 8068, Asheville, N. C. Parachute, cargo, 38 ft. canopy (IFB MIPR-R-57-6-8004-QM-(07) and Amend 1, 2, and 3) 702 ea. $92,137.

Revere Corp. of America, 845 N. Colony Rd., Wallingford, Conn. Stud, bracket (RFP PR MA-7-05D-38) 5,760 ea. $79,739.

Ledkote Products Co. of N. Y., Inc., 39-01 Vernon Blvd., Long Island City, N. Y. Section & clevis assy. (RFP PR MA-701471) 1,193 ea. $47,054.

Phillip Formel Co., 45 E. Putnam Ave., Greenwich, Conn. Construction of reinforced concrete foundation and erection of AB-259/FPS-6 arctic type tower and associated facilities at Claysburg, Bedford County, Pa. (IFB PR (MAMN) 57-207-1) $56,000.

OKLAHOMA CITY AIR MATERIEL AREA, Tinker AFB, Okla.

Lunn Laminates, Inc., Oakwood Rd & W. 11th St., Huntington Station, N. Y. Dome Nav observing. (IFB-34-601-57-295-OC-691346-C1) 1 item $37,354.

Bowers Electric Co., 1316 E. Madison, Oklahoma City, Okla. Installation of electrical distribution system, Tinker AFB, Okla., Project n. OC-11-57 (IFB 34-601-57-341-OCBA-57-162) $48,995.

Aero Design & Engineering Co., P. O. Box 118, Bethany, Okla. Technical data. (OC-730409, OC-730335 & OC-730424) 5 items $188,778.

Allison Div., General Motors Corp., Indianapolis, Ind. Overhaul and repair of J35 jet engine components. (OC-730178) $70,915.

CIVILIAN AND MILITARY TYPE: PERSONNEL PARACHUTES BRAKE CHUTES TROOP CHUTES CARGO CHUTES
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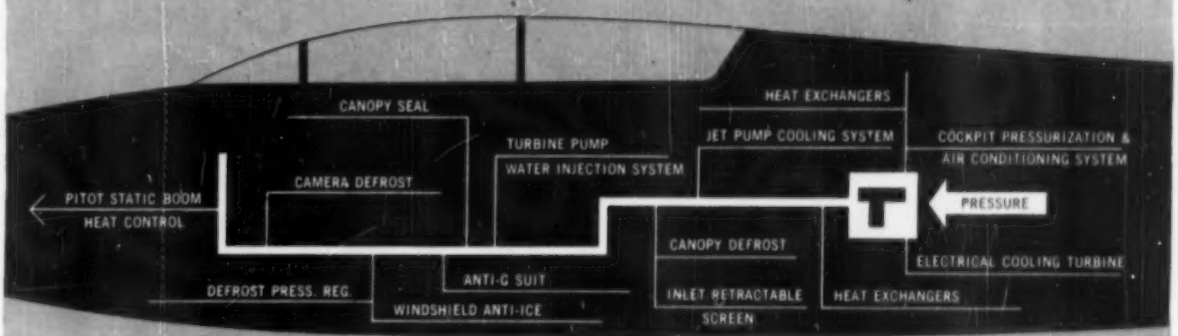
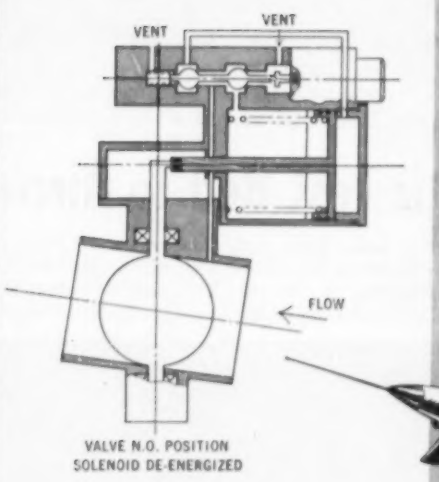
1 all these pneumatic devices serviced by one valve!





Specifications called for a compressor bleed system shut-off valve to bleed off air from the compressor section to service all 14 pneumatic devices shown on diagram.

The valve had to be capable of operating at high pressures; a filter had to be built in so that the air from contaminated sources could be used; and because of proximity to the engine it had to function in temperatures up to 900°F.

RESULT: this Whittaker Butterfly Shut-off Valve—operated by an integral poppet-type solenoid pilot assembly. It incorporates a unique actuator that extracts pressure from the upstream port—thus eliminating external plumbing!

The unit can be adapted to any tube size and is available now.

PERFORMANCE

SERVICE: Hot air
TEMPERATURE: Ambient −65° to +325° F. Fluid −65° to +900° F.
OPERATING PRESSURE: 10 PSIG (Differential across butterfly, 205 PSIG)
ELECTRICAL POWER: 18-30 volts DC Cont. Duty Actuating current .65 amps. max. @ 30 volts and 78° F.
LEAKAGE: Max. internal leakage .25 lb/min. @ 78° F. & 205 PSIG
WEIGHT: 4.3 lbs.
LINE SIZE: 2 inches (can vary for most requirements)

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Gentlemen: Please send me further information on Compressor Bleed System Shut-Off Valve, P/N 120645

Name_____

Company_____

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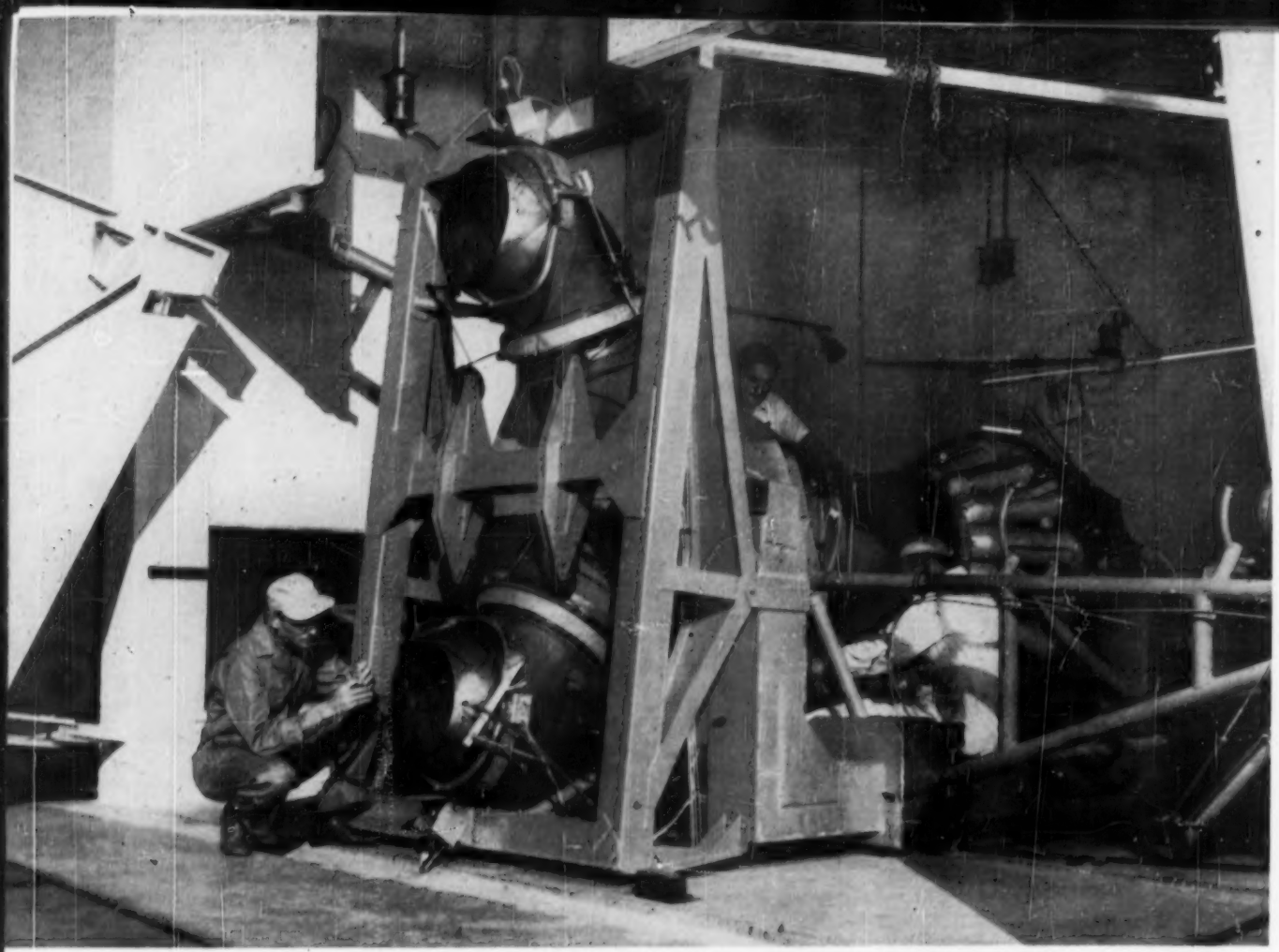
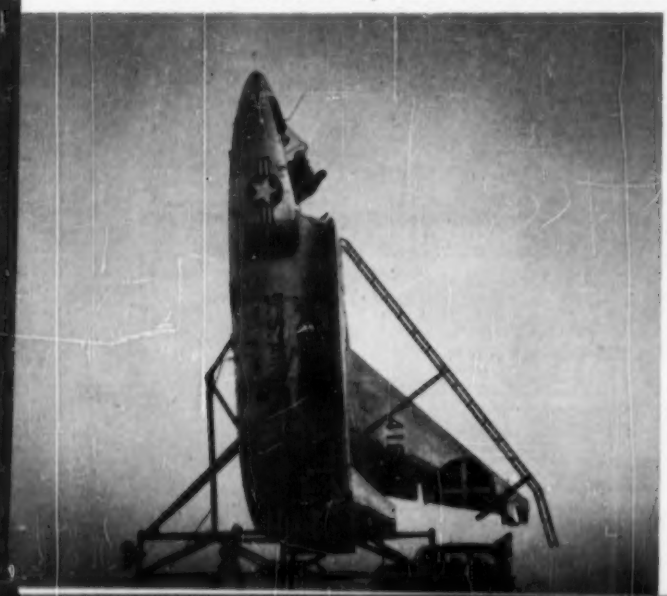
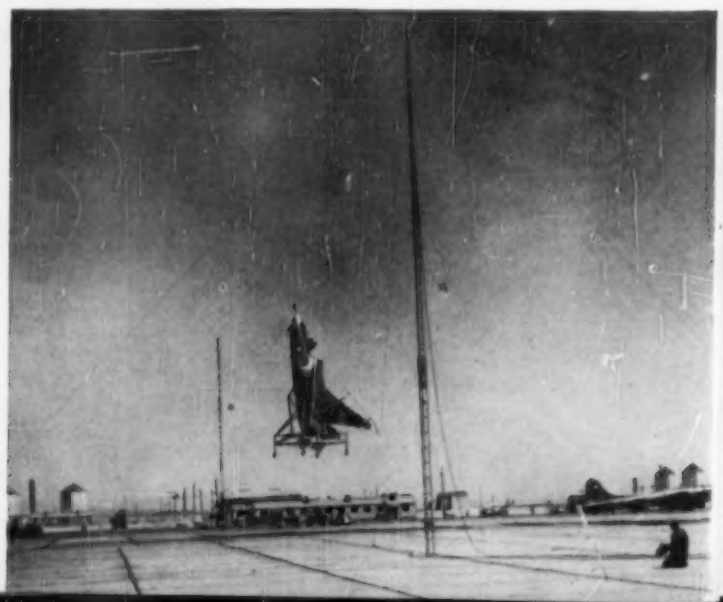


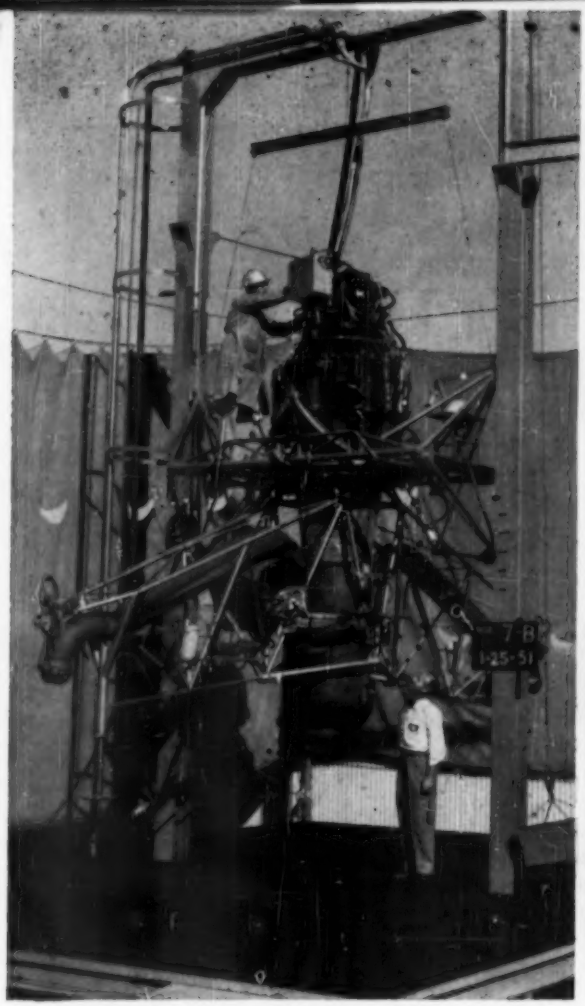
RYAN X-13 hardware development started in 1949 when under USN funds Ryan engineers used exhaust from Allison J33 turbojet to make exploratory studies of various aircraft lift and control methods for VTOL flight. Two eyelid nozzles on a split tailpipe are illustrated above. Other investigations included compressor air bleed to separate control nozzles, vanes in the jet exhaust and even rocket motors.

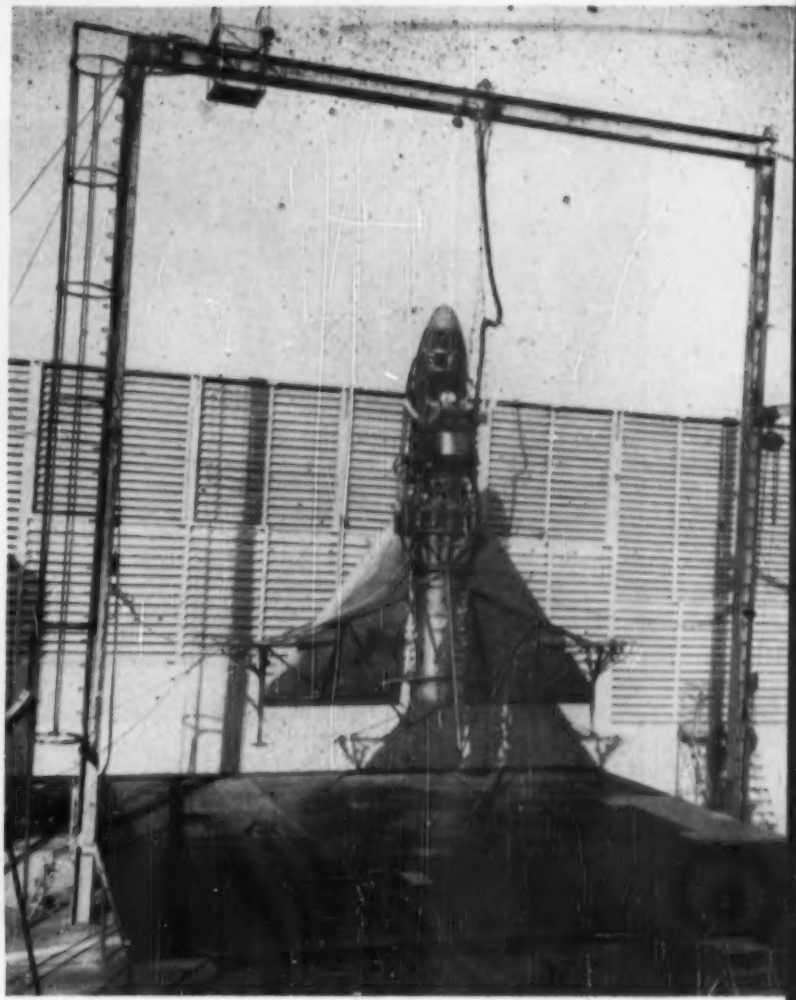
How X-13 Developed From Static Test Bed to Aircraft

IN 1953 Ryan obtained USAF funds to build the X-13 flight test vehicle. Pictures below shows X-13 mounted on tail-sitting "pogo" cradle for vertical testing, both tethered and free. Ryan said that at that time they found the Rolls-Royce Avon turbojet the only available 10,000 lb. powerplant with a thrust to weight ratio sufficient for their VTOL. Starting May 28, 1956, the X-13 made 3-5 minute flights as a tail-sitter. Pilots found they could set the X-13 down within six inches of a mark. Hook-ons to cables were also practiced (right).



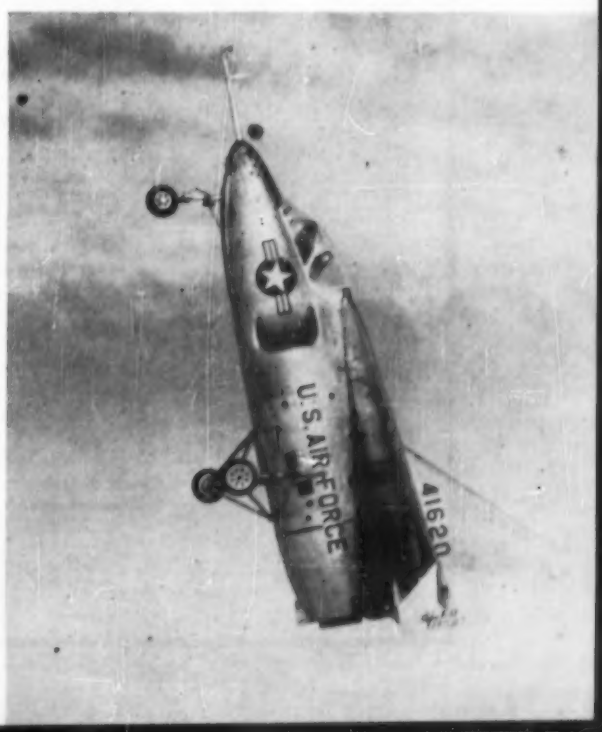






BY 1950 the J33 was "flying" up and down between two guidance rails (left). The first flight minus the guidance rails was on May 31, 1951 and according to Ryan was the world's first free hovering jet flight by remote control. A crude cockpit was added (right) and on November 24, 1953 Ryan said they had achieved the first piloted hovering jet flight.

ON NOVEMBER 28, 1956, transition to vertical and back was accomplished after a conventional take-off (right). Earlier in the program the X-13 had been checked out for horizontal flight (below) and a roll and yaw damper had been added.



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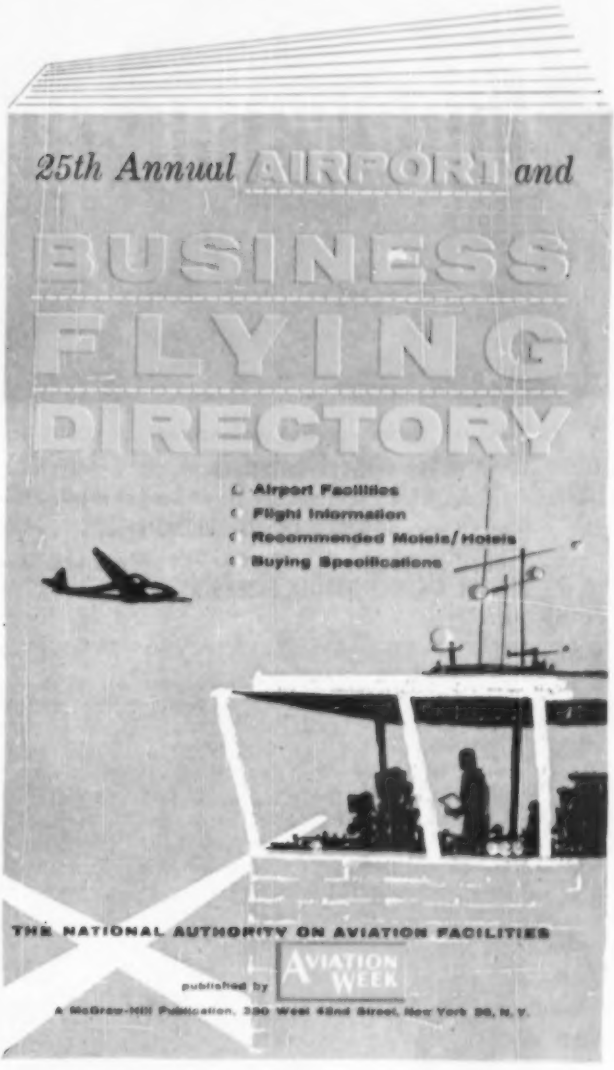

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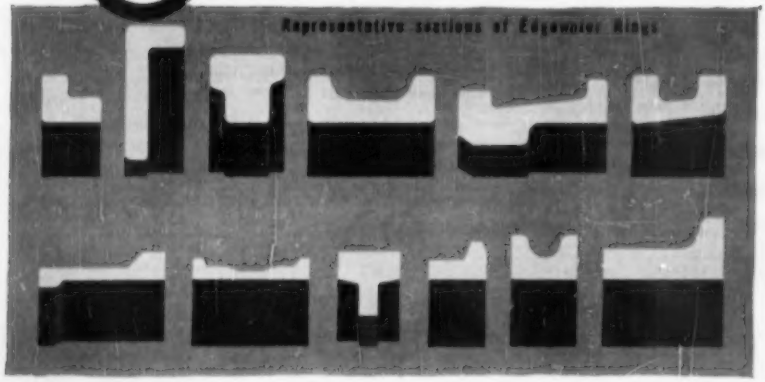


WHO'S WHERE

(*Continued from page 23*)

Changes

Willard D. Walker, chief electronics engineer, Astronautics Division, Convair, division of General Dynamics Corp., San Diego, Calif.

Dexter Rosen, administration department manager, Guided Missiles Division, Bell Aircraft Corp., Buffalo, N. Y.

Brig. Gen. Robert E. Galer (USMC, ret.), manager-engineering programs, Temco Aircraft Corp., Dallas, Texas. also: **R. L. Lewis,** manager of contracts and sales-customer designed products, and **C. C. Convers,** manager of contracts and sales-Temco designed products.

Kostas J. Boudouris to head newly established Denver office of Air France. Also **Mario J. Rondina,** manager, newly established Seattle, Wash. office.

Col. Ralph J. Watson, administrative and engineering liaison representative-Washington, D. C. staff, North American Aviation, Inc., Los Angeles, Calif.

Ralph B. Lightfoot, chief engineer, Sikorsky Aircraft, division of United Aircraft Corp., Bridgeport, Conn. Also: **John P. W. Vest,** chief-engineering operations; **Edward F. Katzenberger,** chief-general design; **Edward Kottsieper,** chief-component design; **Miller A. Wachs,** chief-component development; **Walter Gerstenberger,** chief-dynamics; and **Harry T. Jensen,** chief test engineer.

Sidney G. Rumbold, project engineer-nuclear rocket projects, Aerojet-General Corp., Azusa, Calif.

R. S. Abrams, general manager, and **L. J. Sinnott,** general sales manager, Silicones Division, Union Carbide Corp., New York, N. Y. Also: **H. M. Johnson, Jr.,** product manager-rubber, and **J. E. Lorenz,** assistant manager.

Col. Edwinston L. Robbins (USAF, ret.), sales representative, and **Blaine K. Stevens,** sales engineer, Geneva, Switzerland office, Lockheed Aircraft Corp., Burbank, Calif.

Fred L. Roscoe, commercial domestic sales manager, Bell Helicopter Corp., Ft. Worth, Tex.

Jack Long has joined the Customer Relations staff, assigned to the F-27 propjet and M-185 jet transport sales programs, Fairchild Engine and Airplane Corp., Hagerstown, Md.

Dean A. Harvey, director-contracts administration, Associated Missile Products Corp., Pomona, Calif.

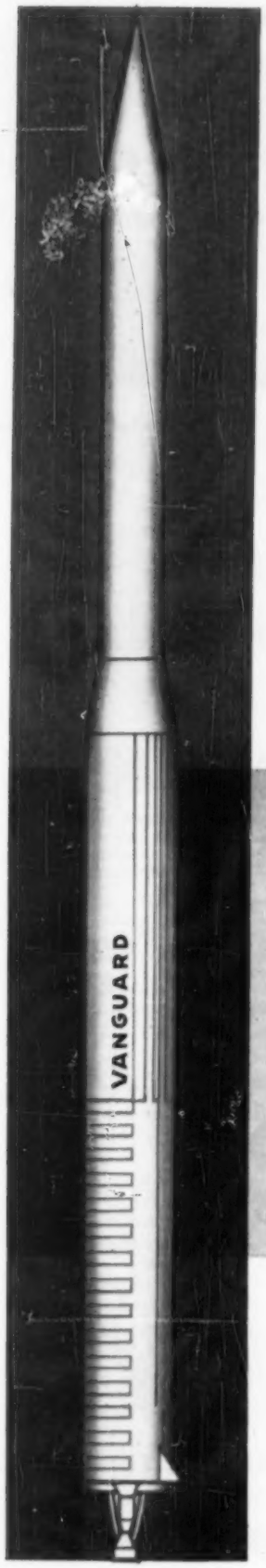
Barclay M. Lewis, manager-New York zone office (Farmingdale, N. Y.), Allison Division, General Motors Corp., Indianapolis, Ind.

Vernon H. Vogel, director-electronic unit, and **John W. Gillings,** director-fluid Controls Unit, Aeronautical Division, Robertshaw-Fulton Controls Co., Anaheim, Calif.

Henry O'Neil, director-advertising, and **Meck Howlett,** director-sales promotion, American Airlines, Inc.

Dr. Thomas H. Johnson, manager-research division, Raytheon Manufacturing Co., Waltham, Mass.

Paul A. Roush, manager-development section, Product Development Department, Flexible Tubing Corp., Guilford, Conn.



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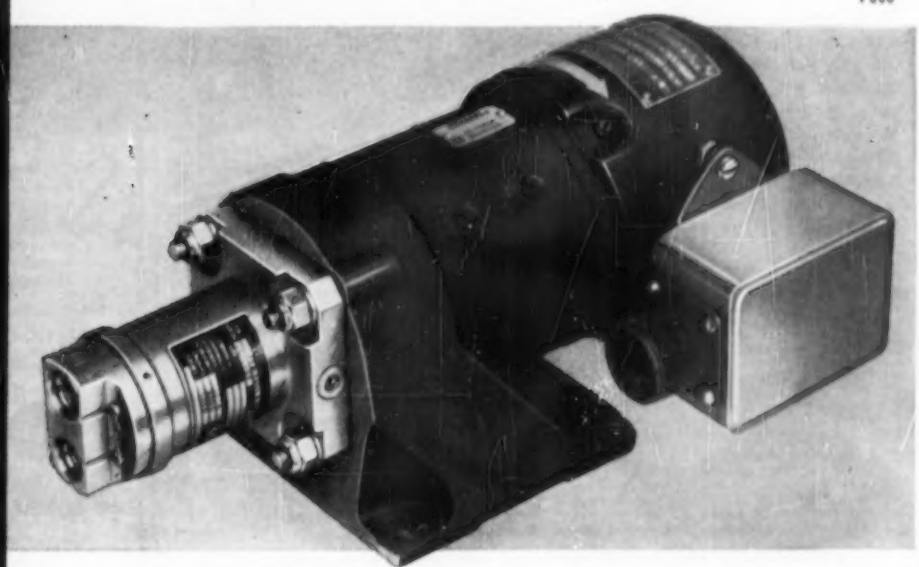

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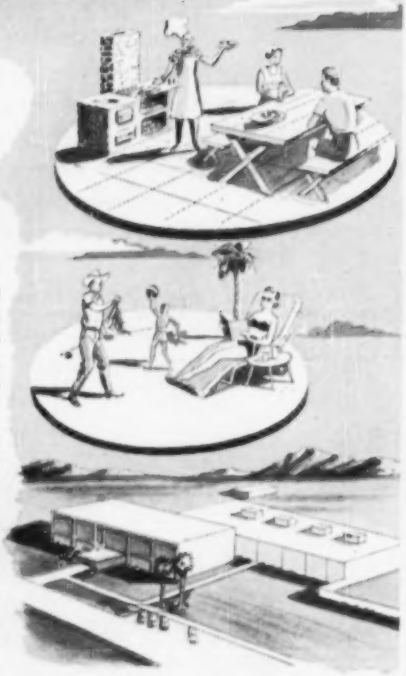

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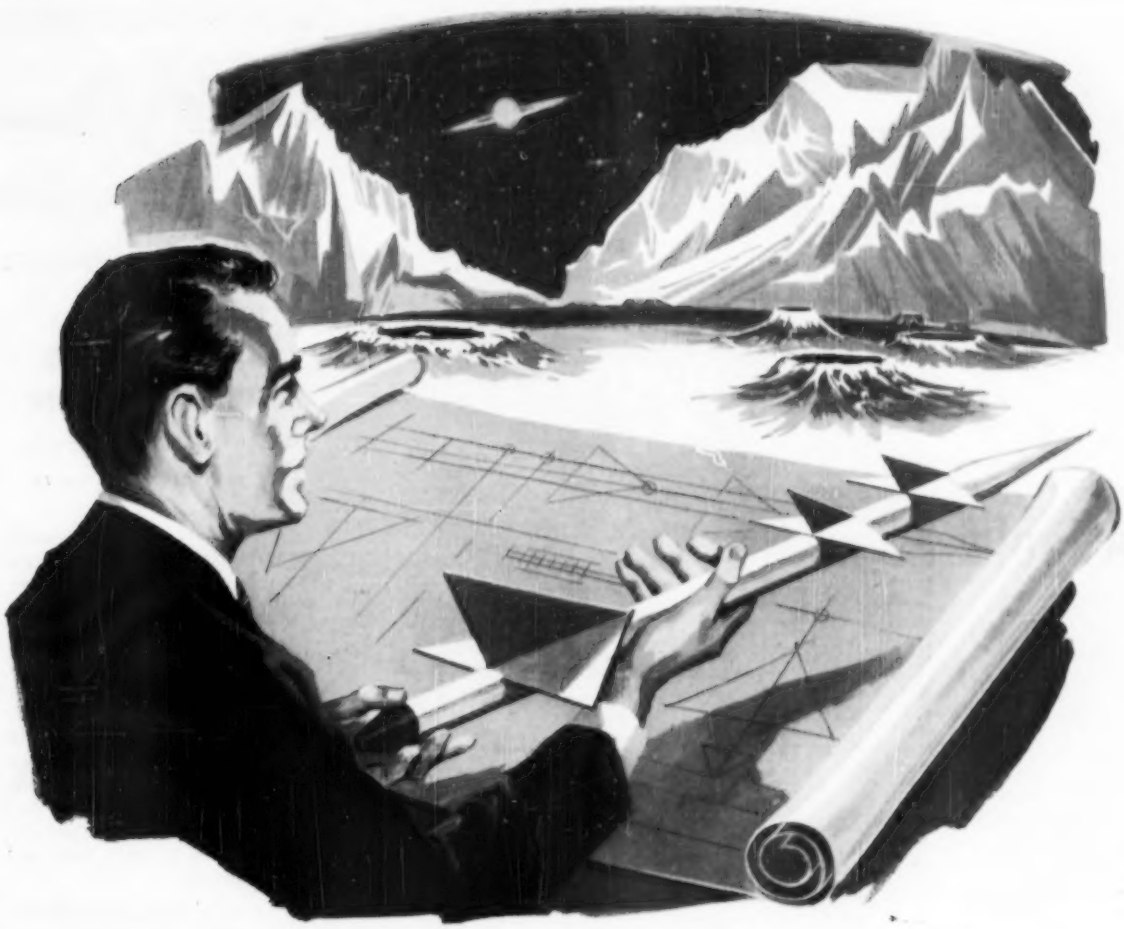

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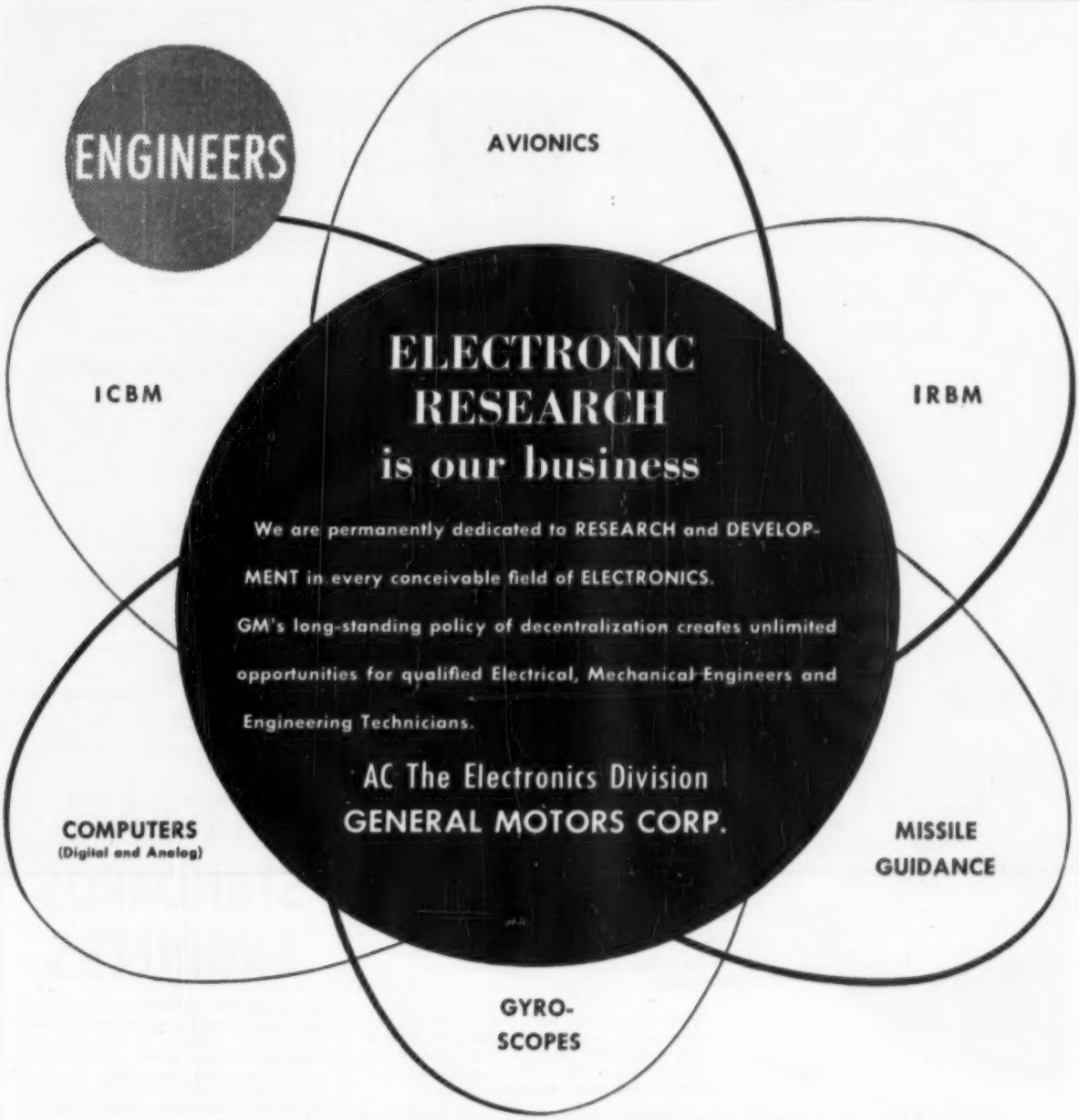
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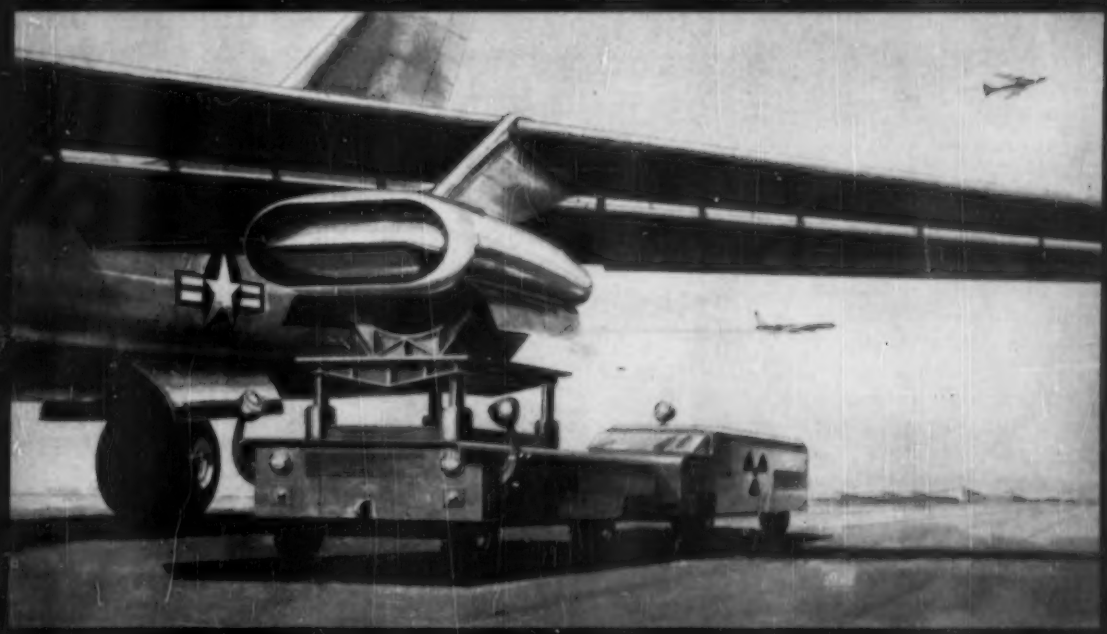

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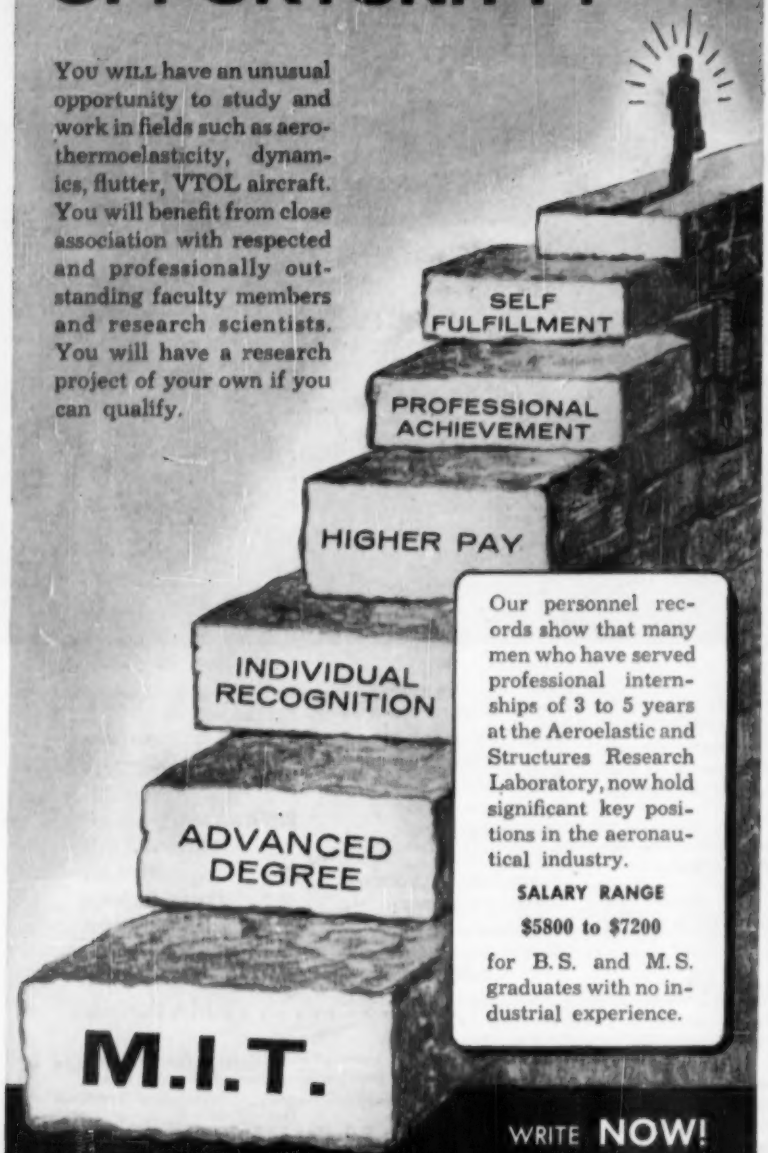

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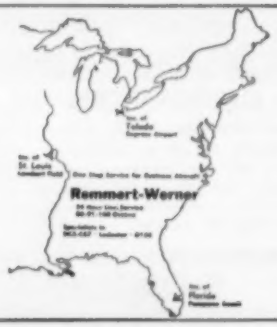

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LETTERS

Replies to Sayen

Re the letter in the issue of July 29 by C. N. Sayen of ALPA (p. 118) concerning the Specht case. It might be well to discard emotion for a moment and examine this letter for what it says—not what it seems to say.

Item: ". . . on the basis of brief and unverified newspaper reports . . ." As I recall, most writers have referenced the article which appeared in AW, which was much less brief than the news report.

Item: "The Safety Agent . . . without making any further investigation . . ." This man obviously had all the information that was available to ATC and his decision was the same as theirs. Did Capt. Specht define his emergency?

Item: ". . . condemned without an investigation, a right to be heard, or a trial." The report that I read indicated that the Captain's license was suspended until a full investigation could be made. Mr. Sayen's remarks about this are extremely self-righteous and calculated to make it seem as if the Constitution were being trampled in the dust. He seems to forget that a man suspected of violating a law is often held in detention—deprived of his livelihood—until the charges can be proven or disproven. This practice is accepted as necessary to the peace and welfare of the community. . . .

This is in no manner connected with his guilt or innocence.

Item: ". . . individuals . . . are now inquiring as to the facts . . ." Yes, Mr. Sayen, we are—and after reading your letter we still are. That letter contained the above comment and then, as has been true of the previous defenses of Specht, carefully does not give us any facts. The entire case hinges on a supposed emergency. Why do the defenders of Specht avoid defining this emergency? It is a useful device to say that ". . . the facts are too complex to be set forth . . ." but it is most useful to those who do not want these facts in print. If Mr. Sayen does have a defensible position, he has in one sentence all but nullified it.

Mr. Sayen has made a series of sweeping and serious charges against CAA, none of which are substantiated in his letter. If he has information—"the facts"—with which to support these statements, it is not his privilege, it is his duty to reveal them in their entirety. If he has no such information, if his remarks are prompted by a pilot's camaraderie, his position is untenable and irresponsible . . . he will have compromised the integrity of his organization. Once again, Mr. Sayen, let's have the facts, not an exhibition of ALPA loyalty and goodfellowship.

JOHN D. MULHOLLAND
Cincinnati, Ohio

The letter of ALPA President Clarence N. Sayen quoted in the July 29 issue of AVIATION WEEK (p. 118) defending Capt. Specht and condemning the CAA and the controllers in that unfortunate case, revives again the defense of Capt. Specht made by the ALPA during the hearing before the CAB. We can applaud the action of ALPA in defending one of its members, but not by using over-worked controllers as whipping boys.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withhold on request.

This Association vigorously protested to ALPA of the manner in which the controllers, called as witnesses for Capt. Specht, were cross-examined by the ALPA lawyer as if they were adverse hostile witnesses. The Association did not, however, enter into the merits of the case with respect to either Capt. Specht or the controllers involved, in that it was presumed that an impartial and fair hearing would be conducted by CAB and that any justifiable criticism of the control exercised would be indicated in the findings of the CAB Examiner.

The only language contained in the report, which in any way reflects on the control exercised is contained in footnote of the Examiner's report on p. 43 and is quoted as follows:

> "33. The examiner does not either condone or condemn the actions of the controllers during this period since this issue is immaterial to the question considered above. Although they obviously believe that Capt. Specht was requesting a change in altitude without apparent reason, the situation might have been obviated by the use of a little tact and patience on the part of the controllers. It is evident that the controllers considered Capt. Specht's request as unreasonable and uncalled for, and because of his attitude were not cooperative to the degree ordinarily to be expected. They suggested no alternatives, such as, a different routing, the possibility of obtaining either 16,000 or 18,000 ft. by delay, or the possibility of obtaining either of these altitudes subsequent to passing Wilkes-Barre. However, it is also obvious that the controllers did not expect or believe that Capt. Specht would leave his altitude without approval."

The above language when reviewed in relation to the report as a whole and its findings indicates that CAB Examiner S. Thomas Simon conducted the hearing in a thorough and impartial manner and that air traffic control was not at issue in this case.

Controllers and pilots must work together as a team and to place them in the middle of this controversy again as indicated by the Saven letter after the case has been completed by the CAB Examiner is not considered justified. I suggest that the Specht case be dropped and that we concentrate on preventing similar incidents in the future.

CLIFFORD P. BURTON
Executive Director
Air Traffic Control Assn.
Arlington, Va.

Coin's Other Side

A (Happy) Jobshopper (AW May 20, p. 158), An (Unhappy) Homesteader (AW June 17, p. 122), and Disgusted Engineer (AW July 8, p. 154) have aired some common (and probably deserved) gripes about the aircraft industry and its engineering working conditions. The implication is that things are only this way in aircraft companies. I get the feeling that they have worked nowhere else and thus may have a limited view which magnifies the gripes out of proportion.

I, too, worked for a large eastern airframe company. Very few supervisors for whom I worked and with whom I was acquainted were impressed or "snowed" by insincere late workers. It would be a poor supervisor who could not judge a man's output by quality but had to resort to quantity as measured by hours expended at his desk. This is the same philosophy that puts an engineer on the time clock and figures that if he came in at 8:00 a.m. and punched out at 4:30 p.m. he must have done eight hours work. Strangely enough most supervisors deserved the positions to which they were promoted.

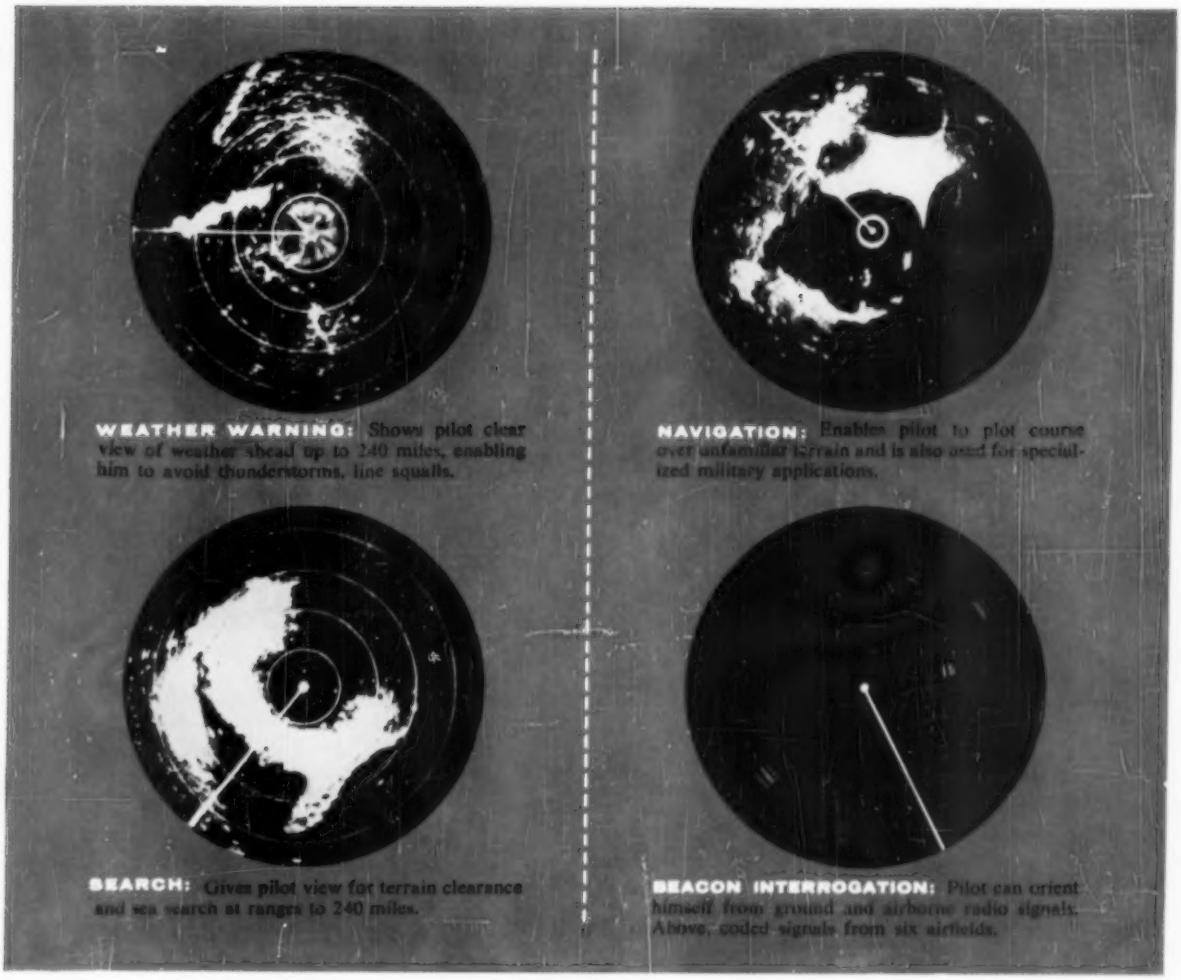
True, some people did little for the good pay received, but I also saw two cases where engineers were fired (yes, actually fired) for such obviously slovenly performance. How often does this happen in "old line" civilian companies?

The implication is always present that people in aircraft work are only interested in spending the government's money and not in economy. True, cost often can not be the guiding light since time is the major element being purchased and this never comes cheap. I worked for a large company in purely civilian pursuits prior to entering aircraft work. There costs were studied to such ridiculous lengths that the local by-word seemed to be "We have got to do it cheaper, even if it costs more."

Engineers with advanced degrees were employed in work that any self-respecting aircraft firm would think twice about assigning to a good technician. Responsibility was unheard of, promotions almost non-existent, and new ideas unwelcome. We hear no gripes from that segment of the engineering population because it has "security" and doesn't want to bite the hand, etc. Any gripes about the work are answered with the old "security" routine.

To Unhappy Homesteader and Disgusted Engineer's question as to where else but in aircraft can one get paid so much for so little, the answer must be in any large organization, civilian or defense. It takes much longer to locate the dud since he can be transferred to many different jobs in an attempt to find a slot for him. It just so happens that aircraft engineers are more vociferous about jobs in general, and such magazines as AVIATION WEEK are willing to air their views for the ultimate benefit of all (we hope).

VICTOR H. GREEN
Electronics Engineer
Cornell Aero. Lab.
Buffalo, N. Y.



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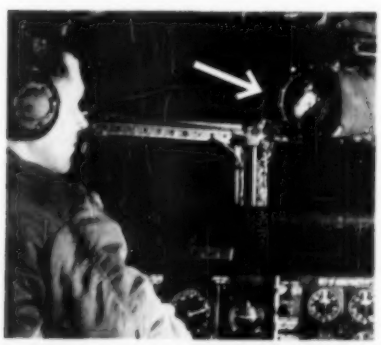

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